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DOE'S NATIONAL ENERGY PLAN AND GLOBAL WARMING

HEARING

BEFORE THE

COMMITTEE ON ENERGY AND NATURAL RESOURCES UNITED STATES SENATE

ONE HUNDRED FIRST CONGRESS

FIRST SESSION

ON THE

FORMULATION OF A NATIONAL ENERGY PLAN AND RELATED POLICIES WHICH AFFECT GLOBAL CLIMATE CHANGE

JULY 26, 1989

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Committee on Energy and Natural Resources

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DOE'S NATIONAL ENERGY PLAN AND GLOBAL WARMING

WEDNESDAY, JULY 26, 1989

U.S. SENATE,
COMMITTEE ON ENERGY AND NATURAL RESOURCES,
Washington, DC.

The committee met, pursuant to notice, at 3:30 p.m. in Room SD-366, Dirksen Senate Office Building, Hon. Timothy E. Wirth, presiding.

OPENING STATEMENT OF HON. TIMOTHY E. WIRTH, U.S. SENATOR FROM COLORADO

Senator WIRTH. The committee will come to order.

Mr. Secretary, thank you very much for joining us. We are absolutely pleased and delighted to have you here this afternoon on an issue of extraordinary importance to the country, the United States and to everybody around the world.

Let me start, if I might, with just a brief comment on your forthcoming statement about a national energy strategy which I believe is absolutely the place to start.

It is increasingly clear that U.S. energy policy is inextricably linked to national and global environmental integrity. As Dr. Gregg Marland from Oak Ridge will testify a little bit later this afternoon, the United States share of global CO_2 emissions is growing rapidly. We are fouling much more than our share of the global commons.

During the past two years, the U.S. contribution to CO_2 spewed into the atmosphere surged by 5 percent, and world emissions set all-time records. These are blockbusters and very disturbing developments.

If we are to be a world leader, if we are to exercise our responsibilities as the world leader that we should and want to be, we are going to have to move now. It is time to make carbon dioxide emissions reduction the foremost of several environmental policy goals.

With those who say that this is a global problem and will require global agreements and global solutions I have no quarrel. The United States can and must, however, as it always has, lead the world in protecting the environment. The most effective way to enhance U.S. leadership is for the administration to put forward an aggressive, economically justified package to reduce our contribution to the problem.

We need, and many of us have asked for, a specific plan, a goal for reducing carbon dioxide emission and otherwise going after all of the problems that relate to our international global environmental problems. Energy policy will necessarily be at the core of these efforts.

It is a great privilege for us to have you back, Mr. Secretary. The great challenge that is being faced in this energy and environmental world is in fact groundbreaking. I know what a major set of problems you have in sort of cleaning up the laundry relating to the other half of your responsibilities. I do not think any of us envy you your job, but we are deeply grateful that you are there and that the adminstration had the good judgment to appoint you to this very important task.

We look forward to hearing from you today, and before asking you to comment in whatever way you think will be appropriate, I would ask the distinguished Senator from Kentucky for any opening statement he might have.

[The prepared statements of Senators Wirth, McClure, and Burns, follow:]

STATEMENT OF THE HONORABLE TIMOTHY E. WIRTH

Good afternoon. It is indeed a pleasure to have Secretary Watkins back with us in the Committee again. In his first four months in office, Admiral Watkins has received broad, bipartisan praise for the job he is doing. I join in that praise. The Secretary is off to a marvelous start.

The Secretary's responsibilities have taken on new weight in the past two years. Enormous responsibilities for energy and national security have emerged -- including rising oil imports, restoring the integrity of the nation's Nuclear weapons complex, and increasingly, the linkage between the way we use energy and the health of the national and global environment.

Secretary Watkins could, as many observers have noted, go down as one of the most significant Cabinet Secretaries in our nation's history. From where I sit, he is asking all of the right questions to get the job done. He has begun his tenure with skill in the face of enormous pressure. And the need for and development of a National Energy Strategy is another step in the right direction.

The past Administration was given to sending to Congress every two years a 10-page "National Energy Plan" that said the market was working and that the market was the plan. Meanwhile, the activities of the Department took on an entirely new direction. When the Reagan administration began its tenure, 40 percent of the DOE budget went to defense functions and more than 50 percent went to civilian energy programs. Last year, we spent more than 60 percent of DOE's budget on defense programs and only 30 percent on civilian energy programs. Unfortunately, what we bought was a discredited record in managing the nuclear weapons complex and an energy picture that looks worse than it did just prior to the oil crises of the 1970's.

In the development of a National Energy Strategy, I would like to submit that environmental protection must be our top priority. Rapidly, but unmistakably, the priorities of the nation and the world are changing. The relaxation of superpower tensions and regional conflict is allowing world leaders to focus on environmental issues that strike at the heart of international security -- indeed, to the future habitability of the planet. In my opinion, we are entering a new age when common efforts to protect the Earth's environment will dominate domestic and international affairs. I believe we must begin now: we cannot delay. If we wait, it may be too late to prevent a tidal wave of environmental catastrophes.

The President appears to have recognized this fact. Last fall, he said that those who thought there was nothing to do about the greenhouse effect didn't know about the White House effect. He pledged to host a major conference on the global environment in the United States. And just two weeks ago, the Paris G-7 communique included a declaration that "decisive action is urgently needed to understand and protect the earth's ecological balance." Further the communique stated that "we strongly advocate common efforts to limit emissions of carbon dioxide and other greenhouse gases."

Buttressing the President's desire to act on these matters, the United States Congress has spoken. Two years ago, we passed the Global Climate Protection Act which requires the President to develop a comprehensive plan on global climate change. And last year, the Energy and Water appropriations bill asked the Department of Energy to evaluate the options that would be required to reduce carbon dioxide emissions by 20 and 50 percent.

The National Energy Strategy is the place to start. It is increasingly clear that U.S. energy policy is inextricably linked to national and global environmental integrity. As Dr. Marland will present in later testimony, the United States share of global CO2 emissions is unparalleled. During the past two years, the U.S. contribution to the CO2 spewed into the atmosphere surged by 5 percent and world emissions set all time records. These are blockbuster and distrubing developments. It is time to make carbon dioxide emissions reduction the foremost of several environmental goals of energy policy.

To those who say that this is a global problem and will require global agreements and global solutions, I have no quarrel. However, the United States, can and must, as it always has, lead the world in protecting the environment. The most effective way to enhance U.S. leadership is for the Administration to put forward a modest, economically justified package to reduce our contribution to the problem. We need, and many of us have asked for, a specific plan -- a goal -- for reducing carbon dioxide emissions. Energy policy will necessarily be at the core of those efforts.

I look forward to receiving today's testimony and discussing these issues with our witnesses. Once again, we thank you all for coming.

# # #

OPENING STATEMENT
SENATOR JAMES A. McCLURE
COMMITTEE ON ENERGY AND NATURAL RESOURCES
THURSDAY, JULY 26, 1989 (3:30 P.M.)

NATIONAL ENERGY STRATEGY AND GLOBAL CLIMATE CHANGE

Good afternoon. Mr. Secretary, five months ago this week you appeared before this committee as the President's nominee for Secretary of Energy. I observed at the time that there was a clear need within the new Bush Administration for a strong and articulate Secretary of Energy who could serve as the focal point for a national debate on the direction of the United States' energy policy as we enter the 21st Century.

I also observed that with all the problems facing the Department it would be easy for you to lose sight of perhaps the most important task facing you as Secretary of Energy; namely, the formulation of a long-term, comprehensive, and consensus-based strategy to foster not just the efficient use of available energy supplies but a strategy to foster domestic energy production consistent with the protection of national environmental values.

Frankly, you are to be commended for the reviews you have initiated to rethink, reorganize, and refocus the energy legacy of the previous administration.

What is missing is a national energy awareness. As you know, today the United States is more dependent on foreign oil than it was prior to the

1973 Arab oil embargo. Since 1981, domestic oil production has fallen and consumption has increased. If current trends continue, by 1995 -- only six years from now -- we could be even more dependent on oil imports, perhaps for two-thirds of our oil.

What little energy policy we now have relies almost exclusively on the vagaries of the international oil market. Meanwhile, we grope for a truly comprehensive national energy policy -- not just a quest for conservation or efficiency; not just the need for federal investment in energy research and development; not just the pursuit of helpful tax policies; and not just an effort to forge a regulatory climate in which private sector decisions are made without penalty from second-guessing regulators at a later time. Our energy problems exist not because there is a shortage of domestic energy alternatives, but because of the lack of a long-term, comprehensive, and consensus-based national energy strategy based on the use of available energy supplies -- domestic natural gas and oil, coal, and nuclear power as well as renewable energy and energy efficiency alternatives.

As you know, what is at stake is our economic security, our foreign policy flexibility and our defense preparedness. Such vulnerability is not acceptable.

What continues to disturb me is the short-term perspective of many of the decisions by Federal and State regulatory agencies that have an impact on national energy policy. For example, the abandonment of the Shoreham nuclear reactor as proposed by Long Island Lighting Company and the New York Public Service Commission. One must question whether we are so rich a country that we can afford to needlessly burden Long Island consumers, never mind our nation as a whole, with economic consequences of such an abandonment. It will mean the purchase of more expensive replacement energy and a reduction in the reliability of electric supplies in the Northeast. From the standpoint of national energy policy, not to mention economic policy, such an action is illogical.

But I also must question actions closer to home. This week President Bush transmitted to the Congress his clean air legislation. While the environmental goals for the legislation are to be supported, it is not clear to me what are the full energy policy implications of the legislation and whether they were even considered by the Administration. For example, as I understand the strategy for the control of acid rain, natural gas effectively is the fuel of choice for the United States. While such a national fuels policy may be justified from the standpoint of national clean air objectives, I must question whether it is in the national interest from the standpoint of the United States' energy policy. It seems to me that we may have almost come full circle from the Carter Administration's endorsement of coal as the fuel of choice to selection in 1989 of natural gas as the fuel of choice. What happened to the concept of a marketplace where renewable energy and energy efficiency technologies could compete on a level playing field with coal and nuclear energy? Instead we are proposing to select natural gas as the fuel of choice.

As I stated at the beginning of my remarks, there is a clear need within the Bush Administration for a strong and articulate Secretary of Energy who can serve as the focal point for a national debate on the direction of the United States' energy policy as we enter the 21st Century. From this perspective, I am interested in hearing from the Secretary as to whether or not he is being successful in this respect.

This hearing is on the national energy strategy in the context of concern for global warming. The broader question however is, what is our national strategy for achieving greater energy independence consistent with national environmental policies.

STATEMENT ON A NATIONAL ENERGY POLICY

by Senator Conrad Burns

Mr. Chairman. I would like to take this opportunity to join my fellow Senators in urging the early development and implementation of a national energy policy for our country. We are all too aware that the enjoyment of our lifestyles is coming at a price, both economical and environmental. We must be concerned about the increasing evidence that if we continue with business as usual, it may cause global warming and we cannot accurately predict the consequences.

Each of us can describe a myriad of concerns about our dependence on and use of carbon fuels to meet our national energy needs. We all should be uncomfortable that over 1/2 of our oil comes from foreign sources, and most of that must be shipped in tankers. The carbon dioxide and nitrous oxide emissions from vehicles are polluting our cities and may be depleting the ozone layer in the atmosphere. It is hard to be pleased with the fact that parts of the United States and Canada are being showered with sulfur dioxide emissions from dirty fossil fuel electric generating stations. Though natural gas is cleaner burning than oil and high sulfur coal, it still emits pollutants to the atmosphere.

In addition to the problems caused by fossil fuel burning, it is sad to see so many nuclear plants shut down from internal problems and from public distrust of safety practices. It is unfortunate that we have not opted to promote and further utilize bio-fuels such as ethanol and methanol since they are clean burning and could be made in large quantities from vegetable matter and many other sources. We have not really begun to develop the potential technologies in fuel cells, solar collectors, and wind generators.

Montanans are proud of their comfortable climate and clean air, and they have as much concern as anyone about the potential harm of the global warming phenomena. We offer our capabilities and our natural resources to help change our present course of action. Montana has abundant low-sulfur coal reserves. Montana has immense capability to produce agricultural crops for use in alcohol fuel production. Montana has large National Forests that provide excellent carbon storage syncs while growing and when utilized in solid forms like lumber and pulp. Montana has clear skies, a criteria for solar energy collection.

We must take measured steps. We cannot let our concerns with the environmental issues drive our energy policy. We have to fight a tendency by some to place tighter and more rigid standards on emissions without regard to technology and reasonable capability. Others would stop all domestic gas and oil exploration to "force" us towards alternative fuels.

We all enjoy our air conditioned artificial environments and the freedom we get from our automobiles. Who is ready to give up their VCR, clothes dryer and microwave. We can pull together and make amazing progress if we can set out goals that everyone understands and commits too--like we did with the moon landing goal in the 1960's. I am ready to roll up my sleeves and get on with the development of a national energy policy.

Thank you.

Senator **Ford**. I have no statement, Mr. Chairman. I look forward to the Admiral's testimony and questions we might have for him after his statement.

Senator **Wirth**. Thank you very much.

Mr. Secretary, I know you are also here at a time when the President has just come back from quite an extraordinary G7 meeting in Paris in which, remarkably, the issues of the environment were almost dominant in terms of the economic discussion.

So here we are today with a start right here at home, and we look forward to hearing from you. Thank you very much for being here, sir.

STATEMENT OF HON. JAMES D. WATKINS, SECRETARY OF ENERGY, ACCOMPANIED BY LINDA STUNTZ, DEPUTY UNDER SECRETARY; AND W. HENSON MOORE, DEPUTY SECRETARY

Secretary **Watkins**. Thank you, Mr. Chairman and Members of the committee. I very much appreciate this special opportunity to appear before you today to discuss the President's plan for development of a national energy strategy.

This Nation is at a critical juncture in having available to it a reliable, competitively priced supply of energy. Domestic oil production for the first six months of 1989 was at its lowest point in 25 years. Oil imports averaged nearly 8 million barrels per day, a level 65 percent higher than in 1985. Only in the late 1970s did we import more oil.

Environmental concerns are putting new pressures on our ability to use our most abundant domestic fuel, coal. Electricity reserve margins are shrinking across the country. Voltage reductions have already been required in the northeast and right here in Washington.

Meanwhile, New York State officials are rushing to pull fuel rods from a completed, safe, and recently licensed nuclear power plant.

Public confidence in the energy industry is at a new low due to a terrible oil spill at Valdez and to a subsequent series of tanker mishaps.

All of this adds up to an enormous challenge to the President and for the Nation. Our country needs a clear energy blueprint to take the United States into the next century, what we have called a National Energy Strategy.

The President directed me, just today, to lead the development of this National Energy Strategy, an action plan essential to providing this Nation in the years to come with adequate supplies of competitively priced clean energy. This strategy will serve as a blueprint for energy policy and government program decisions. It will contain specific short-term, mid-term, and long-term recommendations.

This strategy will chart our course, set our pace, and provide mileposts by which to evaluate progress in providing the energy our economy needs while protecting the Nation's health, safety, and environment.

The National Energy Strategy will not represent my private opinions or those of particular interest groups or the Department of Energy. Rather, it will be developed from the consensus of views we receive throughout the process.

Accordingly, I have committed the Department to extensive consultations with the Governors and State officials of this Nation, with Members of Congress, with industry and with the American people.

Beginning in August we will conduct a substantial number of public hearings around the country. Also, a large number of individuals in private and public organizations have contributed groundbreaking efforts on national energy policy proposals. We will build on those contributions.

With the 21st Century just 10½ years away, we must plan now if we are to have available then a balanced mix of energy supplies. Success in world markets so vital to America's economic future can only be assured if American business and industry can rely on adequate supplies of competitively priced energy. How such supplies are developed and maintained is an issue that has preoccupied the Nation since the energy crisis of the 1970s.

I think you will agree that the time has come to turn this frequently divisive 15-year-old energy debate into a sensible plan of action which is consistent with this country's market-based economy system.

Let me begin by announcing to you that I have decided to substantially increase the responsibility and authority of the Department of Energy's Office of Policy, Planning and Analysis. This office will be henceforth under the leadership of the Deputy Under Secretary, Ms. Linda Stuntz, whom I have here with me today. I am pleased to inform you that I have selected her, a former Minority Counsel of the House Energy and Commerce Committee and a person familiar to many of you, to fill this important position.

I have asked Ms. Stuntz to reorganize and expand this office to assist me in coordinating the policy and program functions of the Department. Her responsibilities will include, among other things, coordination of climate change policy and integration of energy and environmental strategy development.

To the Policy Office working under my direction and that of the Deputy Secretary, Henson Moore, has been assigned the task of crafting the National Energy Strategy. This is a long-term assignment. As I have stated in earlier testimony before this committee, I view the strategy development as a dynamic process, a process that must be responsive to changes in the marketplace, to advances in technology and to domestic and international geopolitical and environmental developments.

If the National Energy Strategy is to gain the support of the American people, it must be built on a reliable foundation of data, analytical tools and forecasting capability. To that end, the Department will work closely with the Energy Information Administration (EIA) to develop the energy modeling system.

That particular branch of the Department of Energy was established by Congress as an independent energy data collection and forecasting agency, and that is the way it has been ever since. Over the years, EIA has established procedures for documenting and making available its assessment of the energy sector, including policy neutral forecasts.

We will start with EIA's current modeling capabilities but are developing plans to extend these capabilities by accessing the best analytic tools that the Department and DOE National Laboratories can employ in this effort.

Furthermore, I have asked the National Academy of Sciences to examine our plans for the development of this modeling system and ensure that it will, to the maximum extent possible, address the critical energy issues before us. These include major environmental issues, strategic considerations and technology research and development.

This modeling system development will be an ongoing effort. It will probably take several years to improve DOE's modeling capability, but I am determined that the modeling system will become the best one in the Nation, the best one that we can employ to analyze the issues facing us.

We have established within the Department a process and several task forces for the National Energy Strategy development. We have mobilized the considerable brain power of our National Laboratories to assist us in analyzing key issues. The laboratories are already at work on four initial special studies. They are to report their findings to me in September.

These are: One, an assessment of the technical and economic potential for energy efficiency and conservation on a sector-by-sector basis through the year 2030, the time frame of the National Energy Strategy;

Two, an assessment of global climate change science and scope of uncertainty. From this assessment will emerge the design of new tools to integrate climate and energy models, models that will be capable of testing energy and environmental policy options;

Three, an analysis of the technical and economic potential for renewable energy technologies and the estimated timing of their adoption by specific sectors of the energy economy assuming various technology and economic development paths; and

Four, an analysis of options to enhance DOE technology transfer to the broader development community. Technology transfer is important not only to meet national energy environmental objectives but to assure that developing nations—which are the fastest growing energy users—will do the same.

In the weeks and months to come I intend to request further analysis and support from the National Laboratories and from other respected institutions around the Nation to address other critical energy policy issues.

Among these will be: One, our need for new electricity generating capacity. Many regions of the country are operating on dangerously low reserve margins. Aggressive conservation efforts will likely reduce the need for new capacity, but we will need new power supplies to meet the requirements of a growing economy.

Two, our dependence on imported oil. Our need for oil will continue to rise even with a strong commitment to increased efficiency and alternative fuels. This commitment is evidenced by the President's support for higher auto fuel efficiency and by the inclusion of alternative transportation fuels in his Clean Air Act proposal.

In this connection I feel fortunate we have gone through that process. However Congress amends the Clean Air Act will be a centerpiece for development of the National Energy Strategy just as it will be for all other aspects of environmental concerns, including chlorofluorocarbon reduction and their eventual elimination. We, at the Department of Energy, are fortunate for having gone through the pains and effort as a major participant in the development of the President's Clean Air Act proposal.

The results of the work to be undertaken by the Interagency Commission on Alternative Fuels—created by the Alternative Motor Fuels Act of 1988—will serve as one important input to address this issue.

Of course, I have with me, on my right, Mr. Henson Moore, a former Congressman, who is now my Deputy Secretary, who will chair the meeting and has already chaired the first council under the Alternative Motor Fuels Act of 1988. We are off to a good start in laying out our program for interagency cooperation in this important subset of the National Energy Strategy, which will be moved in parallel with our other developmental efforts.

Lastly, our stewardship of the environment. Energy production, transportation and use can be managed in an environmentally beneficial manner, but as recent events have shown all too well, risk will always be present. The American people will rightly demand that we do a better job of reducing harmful emissions, managing hazardous waste and improving the technology to prevent and clean up oil and chemical spills.

The potential for global climate change is a central issue in NES development because the majority of greenhouse gas emissions and of responses for their reduction involve production and use of energy.

Six principles form my approach to global climate change policy: take aggressive action on those issues in which scientific consensus exists assess the state of the science on issues where no scientific consensus exists; and identify areas for further inquiry; where scientific uncertainty exists, move forward with those measures that make sense on other grounds, for example, efficiency and reducing chlorofluocarbons consider the cost and benefits of any response measure suggested; link responses to scientific and technical information; and determine how to evaluate and share technological responses with developing countries.

It is entirely proper that the Department of Energy assume a leading role in reducing the scientific uncertainty and in defining the initiatives that can be undertaken—publicly and privately—in response to this threat.

Energy affects virtually every aspect of our economic life. A national energy strategy will need to address issues as diverse as investment policy, technology research and development, international trade, and energy prices. We will need to consider the impact of our policies on the American consumer, especially the poor and those individuals in businesses whose access to energy is critical to their economic survival.

We will also need to consider the effects of our policy choices, the action of our allies, of developing countries, and of the centrally planned economies.

For all these reasons, the NES will need to be developed intergovernmentally. To that end, I intend to invite my colleagues in the cabinet and in other Federal agencies to work closely with us from the outset on this important task.

At local, State and regional levels I will seek the advice and counsel of the elected leadership. The initial fact-finding public hearings we have scheduled for August and September are intended to begin the policy consensus building process from the ground up. We want to hear what the local and regional concerns are from those who are charged in a very direct way with meeting the requirements of their immediate constituency.

In addition, we intend to work very closely with the members and staff of this committee and of other interested committees of Congress.

In conclusion, we can no longer postpone reconciling the energy requirements necessary to support the standard of living Americans expect, and our desire for a safe and healthy environment. I pledge to you that the National Energy Strategy will be built around this fundamental premise.

By April of 1990 we plan to have available a first draft document that should help the Congress to understand the direction of our national energy policy and how we plan to achieve it. This first draft should be good enough to allow continued dialogue with all participating entities, to encourage their further comment, and incorporate their concerns before submission to the President, later in the year, for his consideration.

The National Energy Strategy updated as demanded by technology development and other events, should be a living document in tune with the times; a document by which to frame our budgets and set our course for many years to come.

This concludes my statement, Mr. Chairman, and I would be happy to answer any questions you might have.

[The prepared statement of Secretary Watkins follows:]

STATEMENT OF ADMIRAL JAMES D. WATKINS
SECRETARY OF ENERGY

before the

COMMITTEE ON ENERGY AND NATURAL RESOURCES
UNITED STATES SENATE
JULY 26, 1989

Good Afternoon Mr. Chairman and members of the Committee. I appreciate the opportunity to appear before you today to discuss the President's plan for development of a National Energy Strategy.

This Nation is at a critical juncture in having available to it reliable, competitively priced supplies of energy. Domestic oil production for the first six months of 1989 was at its lowest point in 25 years. Oil imports averaged 7.8 million barrels per day, a level 65 percent higher than in 1985. Only in the late 1970s did we import more oil.

Environmental concerns are putting new pressures on our ability to use our most abundant domestic fuel, coal. Electricity reserve margins are shrinking across the country. Voltage reductions have already been required in the Northeast, and right here in Washington. Meanwhile, New York State officials are rushing to pull fuel rods from a completed, safe nuclear power plant.

Public confidence in the energy industry is at a new low, due to the terrible oil spill at Valdez and to the subsequent series of tanker mishaps.

All of this adds up to an enormous challenge for the President and for the Nation. Our country needs a clear energy blueprint to take the United States into the next century -- a National Energy Strategy.

The President has directed me to lead the development of this National Energy Strategy -- an action plan essential to providing this Nation, in the years to come, with adequate supplies of competitively priced, clean energy. This strategy will serve as a blueprint for energy policy and government program decisions. It will contain specific short-term, mid-term, and long-term recommendations. This strategy will chart our course, set our pace, and provide mileposts by which to evaluate our progress in providing the energy our economy needs, while protecting the Nation's health, safety, and environment.

The National Energy Strategy will not represent my private opinions or those of a particular interest group. Rather, it will be developed from the consensus of views we receive throughout the process. Accordingly, I have committed the Department to extensive consultations with the Governors and State officials of this Nation, with Congress, with industry, and with the American people.

Beginning in August, we will conduct a substantial number of public hearings around the country. Also, a large number of individuals and private and public organizations have contributed ground-breaking efforts on national energy policy proposals. We will build on those contributions.

With the 21st century just ten and a half years away, we must plan now if we are to have available then a balanced mix of energy supplies. Success in world markets, so vital to America's economic future, can only be ensured if American business and industry can rely on adequate supplies of competitively-priced energy. How such supplies are developed and maintained is an issue that has preoccupied this Nation since the energy crisis years of the 1970's. I think you will agree that the time has come to turn this frequently divisive, fifteen-year-old energy debate into a sensible plan of action, which is consistent with this country's market-based economic system.

Structural Changes At DOE

Let me begin by announcing to you that I have decided to substantially increase the responsibility and authority of the DOE Office of Policy, Planning and Analysis. This office will henceforth be under the leadership of a Deputy Under Secretary.

I am pleased to inform you that I have selected Ms. Linda Stuntz, former Minority Counsel of the House Energy and Commerce Committee, and a person familiar to many of you, to fill this important position.

I have asked Ms. Stuntz to reorganize and expand this office and to assist me in coordinating the policy and program functions of the Department. Her responsibilities will include, among other things, coordination of climate change policy and integration of energy and environmental strategy development.

To the Policy Office, working under my direction and that of Deputy Secretary Moore, has been assigned the task of crafting the National Energy Strategy. This is a long term assignment, because, as I have stated in earlier testimony before this Committee, I view this strategy development as a dynamic process; a process that must be responsive to changes in the market place, to advances in technology, and to domestic and international geo-political and environmental developments.

Data and Analysis

If the National Energy Strategy is to gain the support of the American people, it must be built on a reliable foundation of data, analytical tools, and forecasting capability. To that end, the Department will work closely with the Energy Information Administration to develop a National Energy Modeling System - NEMS. The EIA was established by Congress as an independent energy data collection and forecasting agency. Over the years, EIA has established procedures for documenting and making available its assessments of the energy sector, including policy-neutral forecasts.

We will start with EIA's current modeling capabilities, but are developing plans to extend these capabilities by accessing the best analytical tools that the Department and DOE National Laboratories can employ in this effort.

Furthermore, I have asked the National Academy of Sciences to examine our plans for the development of the NEMS and ensure that it will, to the maximum extent possible, address the critical energy issues before us. These include major environmental issues, strategic considerations and technology research and development.

NEMS development will be an ongoing effort. It will probably take several years to improve DOE's modeling capability. I am determined that the NEMS will become the best modeling system that we can employ to analyze the issues facing us.

NES Research and Analysis

We have established, within the Department, a process, and several task forces for National Energy Strategy (NES) development. We have mobilized the considerable brainpower of our National Laboratories to assist us in analyzing key issues.

The laboratories are already at work on four initial special studies. They are to report their findings to me by September. These studies are:

1. An assessment of the technical and economic potential for energy efficiency and conservation, on a sector by sector basis, through the year 2030, the time frame of the NES.

2. An assessment of global climate change science and scope of uncertainty. From this assessment will emerge the design of new tools to integrate climate and energy models; models that will be capable of testing energy and environmental policy options.

3. An analysis of the technical and economic potential for renewable energy technologies, and the estimated timing of their adoption by specific sectors of the energy economy, assuming various technology and economic development paths.

4. An analysis of options to enhance DOE technology transfer to the broader development community. Technology transfer is important not only to meet national energy and environmental objectives, but to assure that developing nations - which are the fastest growing energy users - will do the same.

In the weeks and months to come I intend to request further analysis and support from the National Laboratories, and from other respected institutions around the Nation, to address other critical energy policy issues. Among these issues will be:

- Our need for new electricity generating capacity. Many regions of the country are operating on dangerously low reserve margins. Aggressive conservation efforts will likely reduce the need for new capacity. But we will need new power supplies to meet the requirements of our growing economy

- Our dependence on imported oil. Our need for oil will continue to rise, even with a strong commitment to increased efficiency and alternative fuels. This commitment is evidenced by the President's support for higher auto fuel efficiency, and by his Clean Air Act proposal to introduce alternative transportation fuels. The results of the work to be undertaken by the Interagency Commission on Alternative Fuels - created by the Alternative Motor Fuels Act of 1988 - will serve as one important input to address this issue.

- Our stewardship of the environment.
  Energy production, transportation and use can be managed in an environmentally beneficial manner. But, as recent events have shown all too well, risks will always be present. The American people will rightly demand that we do a better job of reducing harmful emissions, managing hazardous waste, and improving the technology to prevent and clean up oil and chemical spills.

The NES and Global Climate Change

The potential for global climate change is a central issue in NES development, because the majority of greenhouse gas emissions, and of responses for their reduction involve production and use of energy. Six principles form my approach to global climate change policy:

- Take aggressive action on those issues on which scientific consensus exists.

- Assess the state of the science on issues where no scientific consensus exists, and identify areas for further inquiry.

- Where scientific uncertainty exists, move forward with those measures that make sense on other grounds, e.g. efficiency and reducing CFCs.
- Consider the costs and benefits of any response measures suggested.
- Link responses to scientific and technical information.
- Determine how to evaluate and share technological responses with developing countries.

It is entirely proper that the Department of Energy assume a leading role in reducing the scientific uncertainty, and in defining the initiatives that can be undertaken - publicly and privately - in response to this threat.

Intergovernmental Process

Energy affects virtually every aspect of our economic life. The NES will need to address issues as diverse as investment policy, technology research and development, international trade, and energy prices. We will need to consider the impact of our policies on the American consumer, especially the poor and those individuals and businesses whose access to energy is critical to their economic survival.

We also will need to consider the effects of our policy choices, the actions of our allies, of developing countries, and of the centrally planned economies.

For all these reasons, the NES will need to be developed intergovernmentally. To that end, I intend to invite my colleagues in the Cabinet and in other Federal agencies to work closely with us, from the outset, on this important task.

At local, State and regional levels, I will seek the advice and counsel of the elected leadership. The initial fact-finding public hearings we have scheduled for August and September are intended to begin the policy consensus building process from the ground up. We want to hear what the local and regional concerns are from those who are charged, in a very direct way, with meeting the requirements of their immediate constituency.

In addition, we intend to work very closely with the members and staff of this Committee and of other interested committees of Congress.

Conclusion

We can no longer postpone reconciling the energy requirements necessary to support the standard of living Americans expect, and our desire for a safe and healthy environment. I pledge to you that the National Energy Strategy will be built around this fundamental premise.

By April of 1990 we plan to have available a first draft document that should help the Congress to understand the direction of our national energy policy and how we plan to achieve it. This first draft should be good enough to allow continued dialogue with all participating entities, to encourage their further comment, and incorporate their concerns before submission to the President, later in the year, for his consideration.

The National Energy Strategy, updated as demanded by technology development and other events, should be a living document, in tune with the times; a document by which to frame our budgets and set our course, for many years to come.

This concludes my statement, Mr. Chairman. I would be happy to answer any questions you might have.

Senator **Wirth**. Thank you very much, Mr. Secretary.

We have been joined by the distinguished chairman of the full committee.

Senator Johnston.

STATEMENT OF HON. J. BENNETT JOHNSTON, U.S. SENATOR FROM LOUISIANA

The **Chairman**. Thank you very much, Senator Wirth. I appreciate your taking over for me while I am trying to get the Energy and Water Bill cleared.

Senator Wirth is our leader on global climate change and has been at the forefront of that fight as well as a lot of conservation issues and other issues in this committee. I want to thank him publicly for continuing to lead that fight.

Mr. Secretary, I am glad to have you and your deputy here. He is well known and well respected and, I might say, well liked by all of us so far. [Laughter.]

We appreciate that.

Before I speak on the subject of that which you testified, I would like to mention that we are releasing our committee print on the economic studies on the Shoreham Nuclear Powerplant. We had a preliminary report earlier. This is the final report.

That report basically analyzes what we were told here in testimony by those who would want to shut down the Shoreham plant when they said that by shutting down this big, new, complete nuclear power plant you save money, which seemed to us as laymen to be absolutely ridiculous. So we put our staff economist to work on analyzing that from the standpoint of an economist, and it turned out to be, indeed, ridiculous as we thought.

The findings are, in fact, that over the first 15 years of operation it cost $.75 billion more to close the plant than it does to operate it. What they had done is to use, for example, one price when they were talking about buying power from elsewhere and another price when they were talking about operating the plant.

All of that is explained in the committee print, and I know that not only you but others will be very interested in that. I hope we can find a way not to allow the dismantling of that plant so that when cooler heads begin to look at that issue they can analyze it not in haste, hastily shutting down that plant, but can look at it from the standpoint of the need for electric power in the northeast and the potential for real pollution in other kinds of energy consumption such as coal and oil, which are really the only other options for the northeast.

I am really concerned, as you know, about the coming electricity shortage in the northeast. I think it could be very serious there. Other regions of the country are in pretty good shape, but for various reasons they cannot supply the northeast. The northeast at this point is in danger of not being able to supply itself. I hope that they can get that done.

Now since Senator Wirth is chairing, I will let him ask the first questions.

[The prepared statement of Senator Johnston follows:]

The Statement of the Honorable J. Bennett Johnston
July 26, 1989

I am pleased to welcome you to this afternoon's hearing to receive testimony on a National Energy Policy and related policies which affect global warming. The United States is currently facing a number of energy policy questions which must be resolved if we are to meet our economic and environmental goals. This nation clearly needs a comprehensive national energy policy which promotes the development of safe, plentiful supplies of competitively priced energy and takes into account environmental considerations such as the greenhouse effect and acid rain.

The fact is that any energy policy is a mosaic of hundreds of different actions. No single initiative can be relied upon to solve our nation's energy and environmental problems, instead, each policy step must be seen as contributing to the overall solution.

First, energy efficiency must be the centerpiece of any viable energy policy, both to preserve domestic energy resources, and to reduce emissions of carbon dioxide and trace gases which result from the burning of fossil fuels. As policy-makers we must begin to recognize the value of energy efficiency in minimizing the growth in greenhouse gas emissions while simultaneously promoting sustained economic growth. The United States has the capability to make energy efficiency technology a viable growth industry. But we must not let this opportunity pass us by.

Already the Japanese and the Europeans stand poised to take advantage of the market opportunities that exist for energy efficiency and renewable energy technologies. Last week, the Energy Committee reported Senator Fowler's bill, S. 488, out of committee which promotes research and development of renewable energy, fosters the creation of joint ventures to promote commercialization, and encourages the export of promising technologies.

In addition, I continue to support nuclear power as an important option for relieving the electricity shortages and environmental constraints we may face in the next century. The threat of global warming provides a compelling incentive for action on the nuclear technology we currently have. The committee has published a report on the Shoreham reactor which shows that it will be less costly to operate the plant than to abandon it. The evaluation also concludes that, when real economic costs associated with Shoreham's proposed shut-down are considered, operating Shoreham will save three quarters of a billion dollars compared to the terms of the settlement. We must act now to remove the barriers to deployment and prove conclusively that nuclear energy can be a safe, reliable, non-polluting source of power for the 21st century.

I would like to focus briefly on one important additional issue. Historically, discussion of U.S. energy policy has focused on issues relating to the reliability of energy supply and price. Well, we have a new component to factor into our National Energy Policy equation -- the Environment. The events of the past year: the grounding of the Exxon Valdez, public alarm over the issue of global warming, destruction of our nation's wetlands, and renewal of the Clean Air Act are proof of this fact.

Taking the proper steps to control environmental problems such as global warming and acid rain, will not be simple. As we shall hear today, the policy choices that must be made entail difficult political and economic tradeoffs. We must realize that America's energy, foreign, and environmental policies are inextricably intertwined. However, encouraging steps are being taken -- At the recent Paris economic summit, the world's leaders made the global environment a major agenda item.

The need for a sound National Energy Policy to address issues such as the environment and national security, has never been more apparent than it is today. But action will require initiative, risk, and perseverance. Under the leadership of today's witness, I am confident that this nation can formulate, and later implement, a comprehensive national energy policy to tackle these issues.

Senator WIRTH. Go ahead, Mr. Chairman. You have to go back and honcho all of those wonderful Colorado items through on the floor, so I do not want to hold you at all.

The CHAIRMAN. I appreciate that. Let me just make a comment about global climate change of which Senator Wirth has been our leader.

In the Energy and Water Appropriation Bill which we hope to take up later this afternoon or tomorrow, we provide $30 million for doing baseline data collection and assessment in determining what the extent of that problem is.

There seems to be no question that we have increased CO_2 and other gasses in the atmosphere. There are some questions about what the effect upon the weather will be, whether that will in fact give a global warming. Some experts I understand even say the opposite, that it can be a global cooling. It is not likely to be a good effect on the climate. It is likely to be a bad effect.

It seems to me that we clearly need to do a number of very difficult things right now based on what we know to be the facts. Other things we may or may not want to do, depending on what the judgment of the scientist is.

It seems to me that while $30 million is a lot of money in one context, when you consider how difficult global climate change may be for not just the environment but for the economy, for the strength of the Nation and for life and health itself, it is a good amount to get started on to do that baseline data.

I have talked to many experts in government about it. Can you give us your view of global climate change at this point?

Secretary WATKINS. We have an intergovernmental group under the Office of Science and Technology Policy in the White House that is coordinating the scientific elements for the entire government. About $190 million is requested for global warming in the Fiscal Year 1990 budget up on the Hill. As far as I know, it has all been protected. I think what you are giving me is something that might be in addition to that.

I believe that number is going to be enhanced as Dr. Alan Bromley comes in and takes over. That position is extremely important for the country, and to have that issue raised to the level of the Science Adviser to the President is extremely important, in that he is coordinating the variety of efforts in NASA, DOE, NOAA and the other agencies that are involved in this process since it deals with all aspects of our lives.

I think that additional monies are probably necessary to move this thing more aggressively. In addition, our laboratories are already working within our current budget. We have requested about $27 million for Fiscal Year 1990, a small component of the $190 million. I think that we are going to probably have to do more. We are gearing up right now to put additional burdens as we build the National Energy Strategy.

So to that extent I do not know what share of this would be allocated to DOE, but it would be helpful for us to know so that we can make our plans for Fiscal Year 1990 right away to enhance what we are doing and move more aggressively.

The President has announced, for example, that we will be involved in the workshop under the Intergovernmental Panel on Climate Change this fall, leading to an international conference sponsored by the United States sometime next year. I think an aggressive effort right now to know what it is and what it is not, as far as the best of the scientific minds in this country and internationally can determine, is critical at the outset so that we can begin to move in a more cohesive way, in a bipartisan effort to really get on top of this, so we know, for example, exactly what the importance of deforestation and reforestation is, and we can begin to calculate those kinds of things and get serious about the variety of things we can do in the near term to minimize the generation of infrared absorbers of all types, not just CO_2.

Remember, that is about 50 percent of the problem. We have other problems. The very fact that we have a Clean Air bill we ought to move that aggressively through the Congress, in my opinion, because in that we are also taking cognizance of global warming when we clean up our atmosphere for other purposes. A call for carbon dioxide reduction, that happens to be an infrared absorber.

So these are all good steps in the right direction, and we need to measure those in the context of global warming. I think that kind of an innovative approach is critical. So I applaud what you are doing there to put more dollars in. I cannot sit here now and know exactly how they would be applied, but I know that we in the Department of Energy want to put more emphasis on it.

In fact, we are establishing a group under Linda Stuntz, here with me, who is heading up the Policy office as Deputy Under Secretary, to pick global warming as a specific subset of the variety of things we have to deal with on the environmental side of the equation.

The CHAIRMAN. I heard the President speak this afternoon at the natural gas ceremony. I know you were there. I was delighted to hear him talk about a new national energy policy which you will be undertaking, which you described. I am delighted with that.

I know you share with me the view that we ought to have a national energy policy that is, so far as possible, made in America, that is domestically produced, that includes conservation which is one of our biggest sources. It certainly includes nuclear. It certainly includes oil and gas and the incentives for oil and gas, and I think my friend from Kentucky would say it includes coal, since we are the Saudi Arabia of coal.

Senator FORD. Absolutely.

The CHAIRMAN. I know you will pursue that, and I do not have to urge you to do it because you and I have had many talks. I think it bears repeating that we ought to have an energy policy that is made in America rather than what we have been doing under this past administration and in other administrations for that; that is, having an energy policy based on imports.

Now one final question, and that has to do with the strategic petroleum reserve. Since we are so dependent on imports and are likely to be increasingly so whatever we do as the future years roll by, it seems to me and I think it is the view of this committee that we ought to increase that strategic petroleum reserve to 1 billion barrels.

One of the best ways to do that consistent with Gramm-Rudman which may bear some real fruit is to encourage foreign countries such as Saudi Arabia to store oil in the United States and lease it to the United States.

Now we have recently passed legislation calling for a study not specifically on Saudi Arabia but on some private group, whether it be a foreign OPEC country, the advantage to them of course being that they can produce it so much cheaper than anyone else, and that they store it in the domestic salt domes and lease it to the United States.

You are familiar with that requirement. How is that study proceeding?

Secretary WATKINS. I am familiar with it. We have had some discussions within the Department.

We are trying to sift out now all of the issues involved in such a leasing program. On its surface it seems to have merit, and that is the way we are approaching this, Mr. Chairman. Maybe Henson Moore, who has been a little closer to the details of exactly where we are in that process, could expound.

Mr. MOORE. The Admiral is correct, Senator. The office of Fossil Energy in the Department of Energy is now working on the costing of that to see exactly what the costing ought to be and how it can be set up. We are indeed interested in it. A very serious study is going on, and we would hope to have some kind of information to be able to sit down and discuss this with the Admiral and ultimately with OMB at some point in the near future.

Secretary WATKINS. Mr. Chairman, I want to make sure you understand. We do believe a billion barrels makes sense. Our biggest problem there is how to fund it. It is about $6 to $7 billion additional to go from the 750 million barrels to a billion barrels. At a time when you are dealing with all the other deficit problems up here, how do we actually fund that?

So I think this is one imaginative area that we are looking into that seems to have merit. I do not have a lot of other simple fixes for the additional burden on the economy of putting those kinds of dollars into the salt domes, but I do think it is a very important initiative.

Our voracious appetite for oil, despite what is said by many to the contrary, is still there. We are going to need that oil; therefore, the imports will continue to increase. The problem is if we want 90 days supply, we have to keep putting oil in those domes to hold that amount, which I think makes sense. All our analysis indicates that is about the right time frame to demonstrate we have the potential to stabilize prices under an extreme condition such as we have seen before.

I think, therefore, that any other ideas like this certainly we would want to communicate with you on, and it would also be part of the National Energy Strategy. So it comes at a very timely point to look at these kinds of imaginative ideas to see if we can get around some of the problems and still achieve the basic objectives of the reserve.

I believe communication with the Saudis may indicate that they are very interested in that kind of thing. I believe that the sincerity that we heard from a number of the Gulf states in our communication with them, on a bilateral basis, indicates that they do want stability in those outyear projections for the world.

I think we have learned a lot of lessons in the past. Everyone has learned those lessons. I believe it is time now to try to cement programs which can give stable projected oil prices for the future.

The CHAIRMAN. Thank you very much, Admiral Watkins. Thank you, Henson Moore, and thank you, Senator Wirth, for letting me barge in.

Senator WIRTH. Thank you very much, Mr. Chairman.

Senator Metzenbaum, do you have an opening statement you would like to make?

STATEMENT OF HON. HOWARD M. METZENBAUM, U.S. SENATOR FROM OHIO

Senator METZENBAUM. Admiral, when you were up for confirmation I indicated I really was quite impressed because I think you have a reputation of being a doer and not just a talker. I think you have a lot of courage and the courage of your convictions. I still believe that.

I must share with you a sense of concern, a concern that we are in the talk stage, the planning stage. We get to the point so often around here that we appoint a commission to examine something, we do a study, we hold field hearings, and yet I see not much happening.

I am concerned that you do not become the Bill Bennett of the Energy Department, who speaks well but does not do a hell of a lot. I suppose I could have sugarcoated that. [Laughter.]

Senator FORD. You could have used a different rule of thumb. Do not do that to this nice fellow.

Senator METZENBAUM. No, I do not want to compare you. That is right.

I would just like to sit here and say to you that on the cafe standards issue, there is a tremendous opportunity there to make a real impact, and I am not sure what the adminstration's position is but I certainly know it is not a strong effort to do something in that area.

I think we need the administration's support: legislation with respect to low income weatherization; energy conservation research and development. The administration is just backed up on the whole clean air issue. I see not much combing out with respect to hydrogen fuel or solar energy.

I would just like to offer my caveat which I offer in a friendly manner and not in an angry or critical way. I think it is fine to have field hearings beginning in August around the country, but I would hope that with respect to some of the issues you would come down hard and strong and without timidity to push this administration to do some of the things that I think there is general consensus needs to be done but is not being done for us to have a truly effective national energy policy which takes into account, which you have already mentioned, the questions of the impact upon the environment.

I do not think we are moving rapidly enough. To me, the public hearings are great, but I think that people as intelligent as you can make up your mind with or without the public hearings. I would hope that we might see a more activist role in some of these areas than we have had to date.

It is only fair to say you have not been in that long, but it has been long enough to pick up on some of them.

Secretary WATKINS. Senator Metzenbaum, let me just go back to my experience on the AIDS Commission. Up on the Hill here you had 60 bills, none of which you could get through. The President took a year to develop a national strategy for AIDS. I was the chairman of that commission. If I had reported out without public hearings what I thought on day one, it would have been a disaster.

I believe that we have to go through a process that is a new process. It is unusual in the Nation, in my opinion, for the Executive Branch to extend a hand to the Congress to go through and follow through on a consensus building document, not driven by presumptions on the part of the Adminstration or others, but rather an open set of hearings—we would have base documents.

We have 40-some documents in our hands right now. They are excellent policies, some coming from Capitol Hill. They are really fine, from various organizations and constituencies, the Committee on Economic Development and so forth. These are excellent. They just have no action plan connected with them so we cannot convert them to program. They involve every issue you raised, including research and development oriented in a new way.

So my belief is that we can package this up in a new way, and I think with the lack of credibility which my own Department has right now because of the many problems we face in a lot of other areas, I do not think it is time for us to pontificate on what the National Energy Strategy should be.

I would hope that the members of Congress would be major participants with us, certainly this committee, in helping us frame this strategy in a way that when we finish it we can lop off the extremes on either end and come out with something that we can all say is fair, is balanced, the playing fields are even and we believe we see something now that at least we can work on as we come up here year after year in our budgets and keep it dynamically up.

I do not think that exists today, and I do not know how to get there without going out and seeking the inputs from the plethora of groups that meet with us daily in our office trying to come to grips with us and trying to separate out wheat from chaff, separate out from local self-interest to something that is broader. I think we have the capability for doing this.

I think when you see this, it will be something new. It will be special. It will be action oriented. It will identify obstacles. It may even embarrass some people that if we do not do these things and eliminate them, we are doing the wrong thing for the Nation as a whole.

I really do believe that this is not just words, that if there is substance to it because of the way we are working it and because of the experience we have had in the past that, frankly, the American people know a lot more, I have found out, than we do sometimes trying to sit around the table and divine something with all the self-interest and pressures that creep in. That has been my experience in 25 years here in Washington.

Mr. MOORE. If I could add, when I came through here in my confirmation hearing, Senator Bingaman suggested in this committee hearing that we involve the National Laboratories in assisting us to come up with more than words, with some real analysis. That has been done under the Admiral's direction here in the details of the plan which we have submitted to your staff.

The two questions you have brought up, we have assigned the function to eight of our National Laboratories. They have never been involved before in this kind of a process to ask them to give us an analysis on the areas of conservation potential and renewable energy potential of where we are in the course of trying to build this strategy.

So we are not overlooking it and we are not trying to give it mere words. We actually have our scientists in our laboratories for the first time working on trying to analyze this from a policy point of view and getting back to us with their results in October of this year.

Senator METZENBAUM. Is there some timetable you set for yourself?

Secretary WATKINS. Yes, sir. We plan to complete our hearings on the first draft by the end of this year, submit our draft to the Congress and to the American people through the normal kinds of processes we go with—the Federal Register and others to get it out in the open.

We want to have six months thereafter for comment and a continuing debate. I want to finalize those comments between September 1 and December 1990, present it to the President and, hopefully, convince the President that this makes sense as the National Energy Strategy. Have him adopt the strategy and to instruct me to keep it dynamically up-to-date and to ask the various agencies in the Federal Government to submit their budgets where they interface with this strategy in accordance with it, and to encourage the States and others that we can only influence by this, to get on board and start moving in this direction.

I hope that by that time we have good solid consensus up here in a bipartisan way from the Congress because we will have worked with you. So the time frame is first draft on 1 April 1990, final draft to the President for his approval and announcement by December of 1990. Then we will commence from that point on to keep it up-to-date in a dynamic way.

We will have our data base exposed to anyone who wants to interrogate it and to use it, and hopefully we can then move from administration to administration and budget to budget with some kind of an umbrella framework so that you all know what we are doing in a variety of areas.

Senator WIRTH. I understand building a consensus is a political exercise that you have to go through to get approval or broad agreement for what it is that you want to do. I hope you do move with the kind of urgency that many of us here have urged this administration to move not only in energy but environmental issues.

As you know, on the books since 1977 or 1978 has been the requirement that the administration submit every two years a National Energy Policy Act, and I would suspect that Secretary Moore was one of the people that voted for that statute in 1978.

Is that right, Henson?

Mr. **Moore**. I voted against it, sir.

Senator **Wirth**. You voted against it, right. [Laughter.]

Anyway, it has been on the books since 1978, and this is certainly more than we have seen come out of that.

Let me go to your statement, jumping back to the national energy study and global climate change. You say, "The potential for global climate change is a central issue because the majority of greenhouse gas emissions and of responses for their reduction involve production and use of energy."

Then you go through and talk about the principles, and one is the principle of developing consensus.

Is there any longer any disagreement about the greenhouse effect and the fact that the world is getting warmer, that the issue that remains now is not where it is happening but how much, how fast?

Secretary **Watkins**. I am not a scientist. I think you have a scientist from one of our laboratories that is going to testify before you today. He would certainly be able to give a scientific answer to that.

Senator **Wirth**. Your own assessment——

Secretary **Watkins**. My own assessment is that we know clearly that infrared absorbing gases will generate a greenhouse effect in the laboratory. We know that. We know that they do heat up. We know that there is such a thing as the greenhouse effect.

The problem is can you relate CO_2 to temperature rise on the earth? There is a lot of conflicting data coming in depending on who testifies.

Senator **Wirth**. Where is the data coming in to the negative on that?

Secretary **Watkins**. Temperature increase in the globe versus a greenhouse gas generation, as I understand it from the various scientific inputs we have received, is not that clear.

I am not trying to diminish what we should do. I am not saying that. I am saying if you want scientific evidence that is clear, there is a significant debate still under way with our own scientists on both sides of the line.

Senator **Wirth**. With all due apologies, if I might, Mr. Secretary, in a short period of time, I think if we look at the record that has been developed in this committee, the record that has been developed on the House side, the record that has been developed by one scientific group after another across the country from the National Academy of Sciences to every other group, the issue no longer is this happening but how much how fast.

I find it interesting——

Secretary **Watkins**: I would go along with that kind of a statement as to how much how fast, but I think it is the how much that is in the contest that I have heard. I know clearly that if you just look at CO_2 alone, it has grown since the early 18th Century in this country. It is fairly well documented now in a variety of models. You can see what it is estimated to rise say between 1970 and the year 2000. It is estimated to go up by 50 PPM, and that was how much it went up for 200 years before that.

We know that that is a significant contribution to absorbing infrared as one of the key contributors to the greenhouse effect.

Senator WIRTH. That is a step in the right direction.

I am just so pleased that you are here and giving us a forthcoming statement on this set of issues as you have, because a year ago it was even much more contentious as to whether anything was going on at all, any actions ought to be taken.

Your statement now that you agree that the issue now is how much how fast and a lot of steps ought to be taken is certainly a step in the right direction, and many of us would like to do everything we can to encourage that along.

Have you, yourself, had briefings from atmospheric scientists on the issue of global warming and global climate change?

Secretary WATKINS. I have had some, Senator Wirth, with the Rocky Flats issue and———

Senator WIRTH. I understand. Do you know if the President of the United States has had any briefings from the scientific community on global atmospheric change?

Secretary WATKINS. I assume he has because he is very conversant on the subject, as he evidenced at the recent economic summit.

Senator WIRTH. We would be interested in getting, if you might submit to us, a list of the people who have briefed you or have briefed the President of the United States.

Mrs. Thatcher, if you remember, had a whole day on the issue with the most distinguished scientists that she could find in Great Britain. Our questions going out to the scientific community in this country have not been asked. I have not been able to find a single atmospheric scientist coming out of the independent sector of distinction who has had the opportunity to sit down at the highest level and walk through this is what it looks like, this is why we should be as concerned with the kind of urgency that is necessary.

Secretary WATKINS. We have scheduled at least temporarily six of those people to come before the various hearings that we are going to hold, and we want their data on the record.

I think it is the time to build that kind of thing rather than listening to independent inputs. I have had summaries of the various studies that have been done within our own Department for 10 years on CO_2, for example. I have had those summaries come before me.

So when you say have you had somebody in the room, I have seen enough studies now to know that it is a major issue, and that is why we are putting so much focus on it.

Senator WIRTH. The sense of urgency in understanding that this in fact is going on is no longer an issue of debate. The question is how much how fast. As soon as that gets internalized, as soon as people understand that, then they view the world in quite a different way.

If they allow themselves to say, well, there is still debate as to whether this is happening, maybe it is, and maybe you have to wait another five years or 10 years for the evidence to come in, that gets them off the hook.

This is an issue on which people cannot be off the hook.

Secretary **Watkins**. We are coming in from that direction, Senator Wirth. I do not think we are in contest with how much how fast.

I do believe that coming from a technical organization, the general consensus among the best scientific minds in this Nation is a very important baseline, and I think that is what we are trying to get now by all of the efforts that we are putting on global warming not only in our Department but other Departments coordinated in the White House through the Office of Science and Technology Policy.

Senator **Wirth**. This is a follow-up before calling on Senator Ford. It might be a good idea to call this the energy and environmental strategy. The two, as you point out in your testimony, are so closely related that we are talking about in terms of the President's statement that urgent action is required to preserve the earth. These two fit together.

I know that energy is your jurisdiction, and the environment is Bill Riley's jurisdiction, but over all the administration is going to come up with this. In many of our concerns is to underscore the urgency of this issue and that we all have to get all of our resources targeted in this direction.

How you think about it, again, gives a very clear signal to people in the outside world that you are serious and you do see the correlation, as you clearly do in your testimony.

Secretary **Watkins**. I certainly understand the correlation. I think you will find that our whole policy of the Department at this point in time, we are trying to change a culture so that those who generate energy have got to be concerned both in the front end design on prevention and certainly have to be ready on remediation of anything that denigrates nature. So we have to start thinking in those terms.

It is the same belief I have on line management, that our people involved in generating energy cannot do it in the absence of a responsible view toward the eventual environmental impact.

I think if you take that away and strip it away and do not allow energy to also by its very nature mean environment, then we are doing it wrong.

So my feeling is it ought to stay just as it is. It is an energy policy but clearly with a heavy focus on the environmental demands on those who generate this energy to not violate the environment.

I think that you will see everything there, so I do not think we are in contention. I would like to see it with that kind of focus and not allow it to dissipate into things other than just environment. We can get into economics, so I can have a national energy, economic, social welfare. I want to make energy responsible for all of these elements, including what we do on things like weatherization for the underprivileged and low-income housing, for example.

Senator **Wirth**. Your statement on prevention and remediation again leads me to finish where I started, by saying how pleased we are to have you here.

Secretary **Watkins**. Thank you.

Senator **Wirth**. Senator Ford.

Senator **Ford**. Thank you very much, Mr. Chairman.

Let me, too, add my support, Mr. Secretary, to what you have been doing since you have been in the office. I find you keep me up to date, that you respond to calls and you respond to information.

Secretary Moore has been more than helpful. He has stood his ground. You all have taken a position and fought for it, and I kind of like that. There is nothing wishy-washy about it. We do not have to worry about where you are. So I am very pleased with that.

Let me ask one thing that worries me just a little bit. We were here during the years of 1976 through 1980, and we found that we had moral equivalent to war as it relates to energy.

Now it seems to me that maybe you are trying to get your agency back into kind of the same spot, reading in your statement and listening to you say it, that you have asked the National Academy of Sciences to examine your plans for development of NEMS and ensure that it will to the maximum extent possible address critical energy issues before us.

You are talking about getting this package together for sometime in late next year. I think you will find some frustration on this committee as to, gee, we have been studying that 10 years. You have a 10-year study that you have read as if you did not have to have anybody in the room telling you about it. You had an opportunity to read it.

I wonder if you are trying to organize these various committees and it turns out to be a camel?

Secretary WATKINS. I do not think so, Senator Ford. I think what we are talking about is more a review by an independent and highly respected body of the modeling system, because I think that in order to use a modeling system that has any credibility up here on Capitol Hill, we are going to have to have an independent review of what the base is of that modeling system. Is it good? Can you draw those conclusions from that model?

I think it is going to be critical that they see what is in that and be comfortable that we have the best model possible in the Nation and that they know what its content is. So it is a technical issue where we need people who have worked with energy for years and years in the National Academy who will understand the key technical elements of any baseline data that we have in our modeling system. That is what we are really focusing on.

I think we can do that in parallel. We will not be finished with the new model, but they can begin to see how we are building that, what is going into it and all the assumptions and rationale so that we have a general consensus that that is a good model, the best in the Nation for dealing with these things and we are under way properly on that rather than to——

Senator FORD. Will this model be given to them before or after your hearings around the country?

Secretary WATKINS. I think we are going to have to build it in parallel with our hearings. We will not be through with the model, Senator Ford. We will have to be building that in segmented fashion as we move through this process, so we have some time to go.

I said it will be about two years, we think, before we can really get it to the point where it is an accepted data base by everybody to look at these various excursions we might have on energy policy ramifications that would be acceptable to you up here.

Senator **Ford**. What sort of things will you be attempting to do in the interim as it relates to progress and movement in various and sundry arenas before you put the model together?

Secretary **Watkins**. May I ask Deputy Under Secretary Linda Stuntz to answer that for you, sir?

Ms. **Stuntz**. Senator, the National Academy of Sciences is already involved in the process of assembling the data base. We warned them from the beginning to make sure that we do not make any mistakes.

Senator **Ford**. The Lord is talking to us. [Laughter.]

Ms. **Stuntz**. We are, in addition, bringing in the National Laboratories, as the Secretary has said, on specific tasks which we hope will give us some white papers even by this fall that we can use at the public hearings to give people something to react to, so we can focus the discussion and make these hearings meaningful and give you and others who are interested in these matters an idea of where we are going.

Senator **Ford**. It seems to me that there is an awful lot of data being collected. We are supposed to have people there report to us on projections and this, that and the other, and somehow it just seems like we are just stirring the broth again. I am sure we are trying to get it on sound footing, but that means two years.

You are on a double track. You are trying to put the model together and trying to have the input and do all that, but we are here doing things. There has to be some leadership, some proposals so that we do not get off track based on where you are trying to go with the model. Yet, you do not know where that model might be taking you. You might have an idea where it is going but, as the Admiral said, he does not want to be pontificating about a national policy until he has it out there where we can begin to look at it with some satisfaction.

Ms. **Stuntz**. If I might add, sir, the model is very important because of the complexity and the multitude of data, as you and people who are interested in this well know. In the end, even the best model that we can build is only a tool. It will be as good as we can build it, but it will still require informed judgments from people to make some of the basic policy choices. Those are the sorts of choices that will really have to result from the kind of consensus process the Secretary has described.

In the meantime, however, we are keenly aware that there are things like the Clean Air bill and other matters that are not going to wait for this to be done. We are doing the best that we can to be aggressive and to consider those in this broader context, because when you are dealing with something like the Clean Air bill, we believe it will have a profound effect on the entire energy industry.

That is not news to you, but we understand that. We are not going to stand on the sidelines and work our models and let everything else go by.

Senator **Ford**. Since you brought up the Clean Air Act, I am ont going to belabor the point. I think you know very well where I am coming from. There is some concern with what the President has transmitted to Congress either this week or last week in the clean air legislation.

For example, a lot of us look at it, and it is a bipartisan effort to try to find some common ground where we can move forward, the strategy for control of acid rain. Natural gas effectively is the fuel of choice in the United States as it relates to that. We all kind of believe that is it. I must question whether it is in the national interest from the standpoint of the United States energy policy that we select a fuel.

Now President Carter selected coal, and that was great, too, but it has gone by the wayside. When the adminstration came in, we did not have all the money left there to continue research and development. It went someplace else. Lord only knows where that money went.

Now we have come full circle, and I think in this legislation instead of renewable energy and energy efficiency technologies being able to compete on a level playing field, I find it looks like natural gas will be selected by this administration as the national fuel.

Do you have any comment? Am I wrong?

Secretary **Watkins**. That was certainly not the intent, Senator Ford. I think the fact sheet that the President opened this dialogue with the American people on just six weeks ago was certainly the baseline of information that we all worked on in preparing the bill.

So the intent is still contained in that fact sheet. As you finally get into drafting a bill of this complexity, a bill over 300 pages long from a 26-page fact sheet, it becomes very difficult to hold such lines as the 10 million tons of SO_2 reduction and so forth. So pretty soon there are elements that drive very hard, and you go back and recalculate and you get into the fine structure of 1.2 pounds for so many Btu, et cetera, and you add these up and it really does not come out to that. There are calculations showing .9 is really the result.

So I understand that, and I think the President again recognizes that in the process that has to go on now there is going to have to be a lot of dialogue with you all up here to try to have the same receptivity that I sensed in the June announcement of the so-called draft sheet or fact sheet that came out.

That was the intent initially. I do not think that intent has changed any, and I would hope that we would be able to work and bring it in line with the concepts that I thought were well aired at that time and fairly well received by all of you up here.

Senator **Ford**. I started in December 1971 and appropriated funds from my state to build a lab to try to find new ways of using coal, taking various and sundry coals, H process, SR1. We went through all that and were on the verge of getting in the Guinness Book of Records until everything was cut off.

I find in the timetable for clean air as it particularly applies to acid rain or clean coal technologies that we are short in time to be sure that those technologies are available to be used to clean up the air and to operate more efficiently or produce higher Btus.

In listening to the testimony from your department, it indicates we have about five technologies that we can use in the near term, and the near term is somewhere around the turn of the century, with substantial time to prove that it will work.

Secretary **Watkins**. Yes, sir. 1998 is about the first time we can make real decisions, and that is why I think the President extended the period of time from January 2003 to the end. That is an extra year, which was in consultation with the National Coal Association and many other people to give additional time for the 1998 decision to reach to the point where we can really give the incentives then to the coal-fired utilities to move in that direction with repowering.

The President very clearly wants to have a level playing field. I think the belief is there very strongly that all sources of energy at this time are good, and we want a level playing field to treat them fairly at this point. There is a lot of competition that has to go on between alternative fuels, between the oil and gas and coal aspects, and these have to be played with fairly. If the thing is unbalanced from that context, I think that is going to have to be worked on.

I do not sense in any way, in the backroom discussions or otherwise, that there is any proclivity on anyone's part to bias this in one direction and unlevel that playing field again. That certainly was not our intent. Our intent was to go in as the DOE participants in this and make sure it did stay level. I believe as far as I know that was the general feeling throughout.

So if we have unbalanced it unfairly, I think those are the kinds of things that have to be worked out.

Senator FORD. I am not saying that you did unbalance it unfairly, but you just said 1998 is probably the earliest date.

Secretary WATKINS. That is for the repowering.

Senator FORD. Right.

Secretary WATKINS. There are some things that can be done in retrofit, as you know. Co-firing with natural gas I think is a——

Senator FORD. Do they call it coal burning or coal-firing or whatever it is?

Secretary WATKINS. Right.

Senator FORD. I have no problems with that to meet the——

Secretary WATKINS. But we have the mandatory barriers that may have to be eliminated there. So there are some things that we know we have to do now to improve the efficiency of those plants to reduce the pollutants. Natural gas is good, but I do not believe there is anybody saying natural gas is the sole answer to all of the issues we face, nor is there any intent to do that.

Senator FORD. We are going to have to help some people on the other side of the aisle, because they believe as I do, that that is the potential of this piece of legislation. As I was saying a while ago, it is not a partisan statement. There are several of us on both sides of the aisle.

Secretary WATKINS. We are pro natural gas, as you know, but I think we are pro natural gas in the sense that it is a clean, efficient fuel and we need to make sure we have no barriers against it.

Senator FORD. I have no problems with that, but you have a bad distribution system. We even had problems last winter down in Texas. They could not get the gas. They had to shut it down and go to alternate fuel and do things like that. We have it running out of our ears.

So the problem is not supply here. It is the distribution system. I went through the winters in Ohio and Kentucky, trying to move things around, driving an 18-wheeler, trying to take care of schools and shifting fuels for penitentiaries and doing all those things. I have been through it. It is like some have been through a depression and others have not, and they do not understand it.

So I have been there, and I am trying to find a way after all these years to make it work for a change.

Secretary **WATKINS**. Senator, let me make a commitment to you.

Senator **FORD**. Let me just finish my statement, and I am going to quit. I do not mean to interrupt you.

The thing that I want is to be sure these technologies we have been working on so hard, that Senator Domenici and all of us have been working on so hard, that we have finally an opportunity to use that technology rather than saying you have to go to scrubbers. We have two companies that make them in this country, and we will have to go overseas, again sending our jobs off our shores. I do not want that, and I do not think you do, either.

Secretary **WATKINS**. No, I do not, Senator Ford. You have a strong ally in that regard.

One of the hearings that is coming up in the near future is going to be held in Louisville. I would like to have a panel of people to come on board. You can give us the names——

Senator **FORD**. I do not want to stack it.

Secretary **WATKINS**. You do not have to stack it. You just have to pick people you respect that you think will have a good handle on this because one of the things in this strategy is going to be those regulatory barriers to progress that we want to expose and identify. Why can we not get the gas where we need it? Why can we not get the most efficient fuel in there if natural gas is it at this point?

If those happen to be pipeline and other barriers or self-imposed regulations within the state or region, then those should be aired. This is the time to do it, and that is what we are going to do in this strategy. It is not going to be a Federal strategy. It is a national strategy.

I would like to have that kind of an input as we go through so we can hammer away at those archaic barriers that preclude us from utilizing all these sources of energy in a profitable way both from the environmental point of view as well as the economic point of view.

Senator **WIRTH**. Let me go to the other side of the aisle.

Senator Domenici.

Senator **DOMENICI**. Thank you very much.

Mr. Secretary, it is good to see you again. I apologize for being late, but I came here because I, on the one hand, wanted to compliment you. I believe you have heard from various members of the United States Senate and various members of the House whenever anything is suggested that is controversial or perhaps even somewhat significant but something new or different. It is always suggested that we should not do it until we have an energy strategy.

I believe it is incumbent upon you to try to develop that strategy. I submit to you that just as I indicated when we were talking about nuclear cleanup in this country, credibility ought to be a very important part of this evaluation. I understand that we want to hear from everyone. We want to get some kind of consensus.

As I see it Mr. Secretary, it is your responsibility when you finally have the facts to put down the strategy and to be absolutely objective and realistic for the American people. There are some things that we can honestly say that the American people want that we cannot deliver.

I am sure if you took a poll, people would say Mr. Secretary, we do not need any more oil. It would be wonderful if we had no more tankers coming to the American shores. There might be a consensus on that.

On the other hand, I believe an energy strategy has to be realistic in terms of assessing where we are and where we ought to be and how we are going to get there in a credible marketplace-oriented fashion.

Is that a fair statement?

Secretary **WATKINS**. Yes, sir, I think it is. I think in my experience, the reputation I gained on the AIDS Commission was one that I was able to listen and then collate that into a useful strategy which I think was pretty gutsy, Senator Domenici. I have no hesitancy about saying what I think is right. I am not going anywhere politically. I am not running for political office. I have no personal constituency. What I left in the Navy is there. So really, I have no qualms about doing that, and I intend to do that.

Obviously we are not going to sit there as potted plants watching the world go by with people in the country who many times have been misled by other than scientifically based facts. I believe it is incumbent on us to hold these kinds of hearings for awareness as well as everything else.

So I think you are going to find that we can get together a package whose recommendations will be probably quite contentious. I know that, but that is what we are going to have to do. We certainly have to identify the obstacles to getting on with a level playing field of energy sources and legitimate environmental demand that are in a balanced context.

Again, we can make some decisions of what the Federal Government, the State, the local industry and regulatory industry should really be doing. I will have no hesitancy to put those out there. I am not sure it is going to make everyone happy, but neither did the report of the AIDS Commission.

Senator **DOMENICI**. Mr. Secretary, let me just raise a couple of points and then compliment you on the use of the National Laboratories and ask you a couple of questions about them. Let me just make this point with you and ask how you think this might evolve.

I think you are aware of the fact that in the United States we have found most of the easy-to-find, cheap-to-get oil and that if we could find it at $18 to $20 a barrel as we did when we found the Permian Basin and other basins in Oklahoma, New Mexico, Texas and Louisiana, we would be out there doing that.

It also is true that conventional drilling yields 30 percent of the oil, and 70 percent of it is underground. It is my observation, and obviously this is only mine with some backup from technical people, that the most efficient production of oil in the future in this country is to take that secondary and tertiary recoverable oil out of the ground quickly. Whatever incentives we build in, we ought to evaluate and see if it is an efficient way to produce oil.

Now before your study, we may get a bill passed to sensitize that marketplace. If we do not, theoretically is that the kind of thing that would be looked at from the standpoint of whether it is recommended?

Secretary **Watkins**. Certainly. As you know, the President did put in four significant initiatives that would affect the tertiary recovery of the remaining resources we have in oil and gas.

We have research and development programs to look aggressively into the various characterizations so that when we drill we may drill at angles. We find that to be much more efficient.

There are a lot of things that can be done technologically, and I do not think the focus has been there. So we want to put a lot of emphasis on that, and I think we can show that there are technical solutions to some of this dilemma we have in going after the last reserves we have and going aggressively after them.

So this is clearly going to be an element of the research and development section of the National Energy Strategy which will be significant and will involve the laboratories as they have never been tasked before, much as we are now tasking them in the area of waste management, toxic waste and radioactive waste management.

Senator **Domenici**. Mr. Secretary, with reference to a secondary recoverability of oil, you will find, I believe, that our Bartelsville Center and others will suggest that a very nominal tax incentive of about 38 cents per barrel would increase the oil reserves in this country 25 percent if it were just put on the books because that is enough incentive for the companies that already own the oil to invest money in it and get it out of the ground.

So there are technical aspects involved, but there are also incentives, and I assume you will be addressing the gamut in that respect; is that right?

Secretary **Watkins**. Yes.

Senator **Domenici**. Let me give you one more hypothetical. Mr. Secretary, assume it comes to you that with the greenhouse effect and other aspects of America's growing energy dependence that nuclear energy should play a more significant role than it is now playing in America's energy future.

Is it fair to say that this strategy of yours, if that was a finding, that you would assess the risks of that versus the risk of not doing it and that we might find some way to evaluate whether or not we should move ahead with the nuclear energy strategy or not?

Secretary **Watkins**. Absolutely. I think that we will cover the various issues surrounding it. I think we will find the following obstacles to nuclear power in the country: lack of credibility that we can manage the technology either in waste or otherwise, probably derived a lot from Three Mile Island and the Chernobyl accident.

I think we have to get the American people educated in that particular area. I do not think they are all that well educated now when they can be misled by public officials in a State to shut down a fully licensed, brand new, high tech, well-run plant. I do not understand that, particularly when they would not participate in the evacuation discussions that FEMA had to conduct. They were actually thrown out of court because the actions they were taking were irresponsible.

So I think when we have that kind of situation to solve that, it is not going to be in the National Energy Strategy unless we can address the variety of elements associated with that situation. Now we need streamlined licensing. We have standardization of reactors associated with streamlined licensing. We have to find the new technologies that will give us a more passively safe reactor.

We believe we have those in hand today looking toward turn of the century interest, but if we do not manage the waste well as another element, nobody wants to invest. We are having a serious problem, as you know, right now in the State of Nevada. I was passed a situation that goes like this.

The Congress said Mr. Secretary of Energy, you will do the studies, the research and development necessary to test the waste repository potential at Yucca Mountain. The State of Nevada has just passed a law signed by the Governor that says you will not do that, Mr. Secretary of Energy. Then when I say I need help, the Congress says you fix it.

That is okay. I will try to do that, but what I am saying is that is an educational process where we have to integrate the variety of things that we need in this National Energy Strategy so that everybody can look next door and say, well, everybody has to eat a little crow to make the Nation still work, and we have to pull together. We do not want to treat anybody unfairly, but we have to have a balanced look at how we are going to manage these various resources.

If in fact there is a decision that we simply do not want any more waste generation from nuclear power plants, then we had better put a lot of emphasis on the real fusion, not the tabletop fusion but the real fusion. I do not see that until 2025 at this point in time even if we aggressively go after the physics unknowns that we now have.

So all of these issues will have to be included in our energy strategy, and there is no question in my mind that we will expose the obstacles to nuclear power and they will be lined up.

Now the recommendations will be another thing, and that is where the potential controversy is going to come in. I think we can all agree on the issues. When the recommendations come, they are going to be tough. I can make tough recommendations; whether they will be bought is another matter.

I will sense the pulse of you all up here and your constituents out there in this hearing process, and I think I will come up with the best answer I can to build a document that is kind of 85 percent on board of what the American people and what you all think.

Senator DOMENICI. Mr. Secretary, I did not get to read your statement, so let me just ask. I assume you are doing this exercise which you so aptly categorized as requiring credibility and a degree of honesty and forthrightness—you had a lot of background—because you, as Secretary of Energy, believe that our growing energy dependence is a very serious risk problem for the United States. Is that a fair assessment?

Secretary WATKINS. That is certainly one, Senator Domenici. I think also environmental concerns are real, and they are of critical importance in putting into the energy strategy.

As I mentioned earlier, I do believe it is time to shift our thinking from the point of view we used to have, saying we are going to give you this energy and somebody else is going to worry downstream about waste management or pollutants and so forth. I think that day has come to a close.

I think the general feeling that it is time for a modernized Clean Air Act, for example, is indicative of the concerns we have in the environment. So that is, frankly, a new element of the energy equation that I think has not been given the attention it deserves.

Senator **Domenici**. Mr. Secretary, I wholeheartedly agree.

I did not get the name of——

Secretary **Watkins**. This is Deputy Under Secretary Linda Stuntz. She is heading up my new policy shop, this restructured office that will be my right arm in development of the National Energy Strategy, and she will participate in the hearings with me. She has experience here on Capitol Hill in energy in the House, and she is a very valuable addition to the staff.

Senator **Domenici**. Thank you.

Senator **Wirth**. Thank you very much, Senator Domenici.

Mr. Secretary, in your statement on the Paris summit in May, you said, "Our efforts here today will demonstrate that there are a number of prudent and cost effective energy responses already justified on economic and energy security grounds which must be implemented now."

Could you give us a list of four, five or six of those that should and are being implemented now?

Secretary **Watkins**. I cannot recall the context, Senator Wirth, in which that particular statement was given. Can you refresh me a little bit as to what is on either side of it? I am trying to figure out where it is. I do not have a copy of that in front of me.

Senator **Wirth**. This was the Energy Minister's summit in Paris.

Secretary **Watkins**. The International Energy Agency in Paris in May.

Senator **Wirth**. I have the full statement here. Why not dig that out and let me move on until you have the whole thing.

Let me jump to carbon dioxide reductions, if I might, while we are looking for the whole context there. We have been talking about the environmental implications of energy policy. Very clearly as you pointed out, a major piece of this is carbon dioxide.

Should there be, do you think, a policy that focuses specifically on carbon dioxide?

Secretary **Watkins**. I think it would be a mistake, Senator Wirth, to all of a sudden select out one contributor as an infrared absorber and say we are going to take that, we are going to put a tax on it, we are going to limit it by a certain percentage.

Senator **Wirth**. But we do have a policy on CFCs. We know that that is an area. We have a very specific policy on CFCs.

Should there be a target for reductions of carbon dioxide?

Secretary **Watkins**. I think there may well be, Senator Wirth, but I am not informed enough to know what that is, nor would I have any baseline of data.

Senator **Wirth**. I am not saying you would have one now or know what the strategy is. The question is should that be one of the targets of the national energy strategy?

Secretary **Watkins**. I think we should look at it. There will have to be some recommendations, Senator Wirth, on the degree to which it makes sense to put some curbs on the generation of those things that are contributing to the scientifically based global warming issue. There is no question about it.

What that should be, I do not yet know. I am just not informed enough to know that.

Senator WIRTH. I understand, but the answer to that is yes?

Secretary WATKINS. Yes, but I think we also have to make sure we understand that while we are decreasing our CO_2 contribution to the world percentagewise—we have gone from some 43 percent, I think, of the world's generation of CO_2 to about 23 percent today, which means that we also have to be very conscious of developing third world and Eastern Bloc nations and so forth, and that demands even more international concern on our part and leadership.

Senator WIRTH. The coming testimony will show that while we may be declining as a percentage of overall worldwide CO_2 production, in the last year and a half, two years, three years, we have shown a marked jump upward, which is very unwelcome news.

Secretary WATKINS. It is unwelcome news, and I agree with you. I am just saying that we also have an international twist to this which is very, very overpowering if we do not get ourselves in the leadership front of this issue.

I think that is why we need the heavy focus at this time to sift some of the wheat from the chaff and get the scientific baseline straightened out.

Senator WIRTH. Let me jump to the international part. "We are the participant in the response strategies working group of the Intergovernmental Panel on Climate Change." They are going to be, as I understand it, meeting here in February.

Secretary WATKINS. That will be the plenary session as I understand it, Senator Wirth. The fall session will be the workshop for that.

Senator WIRTH. The final report will be out in April of 1990. That is the major international agreement that we are involved with; is that right?

Secretary WATKINS. Yes, sir.

Senator WIRTH. Now the question then relates to the national energy strategy which is not going to be out until April 1990.

Have you all looked at the timing of those? It would appear to me that if we are seriously looking at energy in the environment link that we would want to be done well before going to the international group for a set of recommendations.

How do those two work together?

Secretary WATKINS. We will stay closely coupled. We are trying to pick ourselves up by our bootstraps, Senator Wirth. We have a Clean Air bill, too, which will be a significant module in the National Energy Strategy, and that is not even passed by the Congress yet.

So all of these things will be going in parallel with each other. We will be staying close to the IPCC work. We will be watching it very carefully. We do not intend to have the final draft in April of 1990. That will be the first draft. There will be many unknowns left.

So we will have to keep working that problem, and hopefully by September of 1990 we will have gone through a lot more of the international elements of the issue, more scientific data will be coming out of the various laboratories from the scientists working on this, and we will be able to have the best package possible by December of 1990, which is when we hope that the President will receive this from us as an official document for him to adopt.

Senator **Wirth**. Then you will not play much of a role in the IPCC, is that right, if you are not ready to go until quite later in 1990?

Secretary **Watkins**. Let me ask Ms. Stuntz.

Ms. **Stuntz**. Let me assure you, Senators, the Department of Energy has had a CO_2 review and study group for over 10 years. We have provided some substantial support and will continue to do in the IPCC working groups.

We have a delegation in Japan this week addressing potential response strategies. All of this will be fed into the National Energy Strategy, but we will continue to look at the developing science.

I would just add methane, for example, which is one of the greenhouse gases, the developing science is showing us that that is substantially more destructive of our ozone layer than is CO_2, and to the extent we can make even small changes in reducing methane gas, that may be an important thing to do. So we do not want to narrow our focus at this point in time.

Senator **Wirth**. I do not want to disagree with that, but CO_2 is certainly a very, very clear target, and we do not say we are not going to do anything about CO_2 because there is an emerging concern about methane.

Secretary **Watkins**. We have done a lot with CO_2. The dollars going into CO_2 research and what we are doing about that is very significant. We are going to be doing more about that in the future because even if we go to the repowered coal plants, for example, we have 400 years of coal reserve. We have to be looking into the future and get some harvest technology research going into what we do with CO_2.

Is the current technology the only technology for CO_2? I do not believe so. But I do not believe we have focused enough resources in that high risk review in the outyears to know. I think, however, there are some things we can do so that we do not regenerate CO_2 in a scrubber and end up with a pile of things that we cannot bury anywhere.

So I think those are the kinds of things that will be in the energy strategy and the research work to deal with the CO_2 issue as well.

So I am just saying there are a lot of things to reduce CO_2 that if we do it well by amending the Clean Air Act, in research work, in being conscious of the generation of that as one of the important greenhouse gases, I think that is clearly in the strategy and clearly something we are going to go after in a big way. We are not going to sweep that under the rug or give it light treatment. It is going to have heavy treatment.

Senator **Wirth**. Senator McConnell is here, and I think we are about to have a vote.

Let me ask you for the record on the previous item, this comes out of your statement of May 30 in Paris. "Our efforts here today will demonstrate that there are a number of prudent and cost effective energy responses already justified on economic and energy security grounds which must be implemented now."

Would you like to respond for the record as to what those are and what this administration and our government is now doing on that in the context? You can have somebody look back at that.

Secretary WATKINS. Yes, sir, I will be glad to do that.

[The information follows:]

At the May 30 meeting of the International Energy Agency in Paris, France, ministers pledged to pursue a number of prudent and cost effective energy responses already justified on economic and energy security grounds which must be implemented now. These included:

- greater energy efficiency and conservation (including greater efficiency in the production of electricity from existing fuels, as well as more efficient use of energy at final consumption);

- evaluation of the possibilities for making use of less carbon intensive fuels, such as natural gas and renewables, where economic, to meet growing energy demand;

- continued and expanding use of nuclear power, demonstrating safety both in operation and in waste disposal;

- accelerated development of new and improved technologies for:

- more efficient production, transformation, transportation and end use;

- nuclear reactor designs, nuclear fusion power and hydrogen processes;

- carbon free renewables such as solar, wind, and hydro power;

- containment and removal of CO_2 and other greenhouse gases; and

o coordination of national RD&D efforts for these technologies at an early stage, including such actions as:

- assessment of relevant energy technologies;

- exchange of information on demonstrated and innovative technologies;

- collection of data on greenhouse gas and other emission factors for practicable current and future energy technologies and systems.

- international workshops on energy technologies of emerging interest such as artificial photosynthesis and photochemistry, exploitation of geo-pressurized natural gas resources, energy end-use and fuel switching, and low CO_2 coal and other fossil fuel conversion and use.

In addition to the measures noted above, I would add that the phase-out of CFCs is a policy which benefits both goals of protecting our ozone layer shield, and reduction of greenhouse gases. CFCs currently contribute about 15-20% of global warming forcing. President Bush has stated the Administration's intention to phase-out these chemicals by 2000, providing safe substitutes are available.

Senator WIRTH. Senator McConnell.

STATEMENT OF HON. MITCH McCONNELL, U.S. SENATOR FROM KENTUCKY

Senator McCONNELL. Thank you, Senator Wirth. I have just a few moments, and I wanted to come over, Mr. Secretary, and applaud your efforts to formulate a national energy plan and to address a lot of different items, including the growing dependence on imported oil.

I am also obviously pleased, since Louisville, Kentucky is my hometown, that that is one of the four sites in which you are going to be having hearings to gather information for the formulation of that plan.

As you know and as we have discussed several times in the past, Kentucky is the number two coal producer. We used to be number one, and we have a great stake in all this.

With regard to the acid rain bill, for example, we are quite concerned that the timetables in the bill may not give clean coal technology an adequate amount of time to come online. So I am hoping that we can provide at a hearing in Louisville an opportunity for people in that industry to be heard and to come up with the best suggestions that they may have to assist you in the formulation of this national energy plan.

I am glad that you are doing it. I think it is terribly important. I just hope that if we can demonstrate that coal has a role to play in this that your mind will be open to that.

Senator Wirth, I really do not have any questions. I just came over to make that statement.

Senator WIRTH. Thank you very much, Senator McConnell.

Just as a closing word, Mr. Secretary, you mentioned you have been doing this for 10 years. If the Department has been doing this for 10 years, what policy recommendations or what steps have come out of all this research that has been going on for 10 years? May we go back to what was suggested earlier?

We are going through all this. We go around Robin Hood's barn over and over and over again, and what specifically is happening? This has been going on for 10 years, and there is research that has been going on for 10 years. There is a sense of urgency out there just about every place else except in this administration, it would appear, in the country.

I appreciate that you have a whole variety of things going on there and you are new on the block and so on, Mr. Secretary, but I would just in summary like to again suggest to you that there is more than this, that the consensus is very clear in the sense of what we ought to be doing.

In terms of conservation is very clear, I would suspect that that is one of the steps that you will come back and respond to us from your May 1989 data. There is no question about the fact that we ought to be doing that.

We ought to be sharing technologies, and you suggest that.

We ought to be looking at alternative programs, and you suggest that.

It is all there. I am not sure how much more consensus we have to develop. I think what a lot of us would be suggesting is that it is time to move. We know very clearly a whole variety of things, as you suggested last May.

Secretary WATKINS. Consensus on the actions, Senator Wirth, is what I am talking about, not consensus on the problems. We did not need to build much consensus on the AIDS problem, but we have to build a lot of consensus on what we are going to do about it: clean needles and condoms, is that the answer?

All I am saying is there are a lot of people throwing out a lot of answers quickly before we can put it into some integrated cohesive concept, and I believe that becomes very critical to calming the Nation down that we can survive economically and environmentally and do the job maintaining the welfare of our people and do it in some kind of a cohesive fashion.

I do not believe the piecemealing and the selection of isolated elements is the right way to go. I recognize we have to do some things in the near term, but I believe that it is time to put this into a package that makes some sense over all.

So it is a consensus on actions to be taken. That is a different kind of consensus. I had a lot of consensus on the problems, and I need no more of that. I do not think we are studying the problems now. I think we are studying the scientific data, putting it in some kind of logical package so that you can look at it and say you are deriving a different conclusion than I would derive from the same data.

That would be very good if we could get to that point. Today everybody has a different data base with a different investigator doing the data with a different office reporting it out, and we are not sure just who to believe.

I witnessed some of the hearings we have had on just what global warming is. What is the temperature linkage? Have we gone up a degree in the last several decades—those kinds of things I think need to be clarified, and I think we can do that in parallel with taking other aggressive actions and not wait for it to come out.

Senator WIRTH. That is the point. That is why I asked the question.

Just a final note, Mr. Secretary. You have mentioned with great justification the economics of this over and over and over again, and as we look at the economics of it, as you and your staff look at the economics of it, clearly we have to look at the economics at large and not in the narrow sense. We have to look at the overall cost of energy production, the overall cost of energy consumption, as you pointed out in your statement.

We have to look at prevention and remediation. Remediation costs for a lot of energy policies are very, very expensive, and those have got to be factored into the real costs of that energy as well.

Secretary WATKINS. I think that when we put our economic chapter in there, if we have not been fair in the total life cycle analysis of those costs we have not done it right.

What happens is on constituency interest, you extract or leave out certain costs. For example, we have some radioactive waste. The cost benefit analysis said it is not enough to recover the plutonium out of it. We find that they have not taken into account four elements of cost that are very significant, that overwhelm the actual reprocessing and, in fact, it is in our best interest to take it out of those drums rather than generate more.

So I really do feel that we have a responsibility there to bring an openness to the cost analysis of some of these things to make sure we do include all of the relevant costs. Otherwise, we are going to be still debating about whether we should go this way or that way up here, and I think that has to be——

Senator WIRTH. Good for you. I could not agree with you more. There are a lot of aspects of this energy question where constituencies are going to want to do a little selective economic analysis.

Mr. Secretary, we thank you very, very much for being so generous with your time and for your leadership of this important effort.

The committee is going to have to recess for just a few minutes while we vote. Our next witnesses are Mr. Gregg Marland and Mr. Tom Boden, Staff Scientists of the Environmental Sciences Division at Oak Ridge, who are bringing to us this afternoon some very significant information on increased levels of carbon dioxide in the United States and how that compares with what is going on elsewhere in the world.

Mr. Secretary, we greatly appreciate your being here.

We will be back very quickly.

Secretary WATKINS. Thank you, Mr. Chairman.

[A brief recess was taken.]

Senator WIRTH. Dr. Marland, thank you very much for being with us. We appreciate your great patience in wading through all of this. We look forward to receiving your testimony, which I found absolutely fascinating, particularly some of the international comparisons in your table.

So why not proceed in whatever way you feel would be most helpful. We will include your full statement, of course, in the record.

STATEMENT OF DR. GREGG MARLAND, STAFF SCIENTIST, OAK RIDGE NATIONAL LABORATORY; ACCOMPANIED BY TOM BODEN, STAFF SCIENTIST

Dr. MARLAND. Mr. Chairman, I am pleased to be here to discuss the anthropogenic emissions of carbon dioxide to the atmosphere. I have enjoyed the session so far. I certainly find it less intimidating with the lights off and the crowd diminished, so this is just fine.

The written statement that I sent basically includes a tutorial and a collection of data on carbon dioxide emissions to the atmosphere. I might point out that it includes some data which this is its first public release as data we have put together as recently as the end of last week.

We really have not had as much opportunity as we would like to look through it and start to see what the implications are. I think it is organized here, but it is not really clear as to the best way to present this orally. Obviously it depends on looking at the graphs for some of this, but I will try to make some qualitative statements.

Let me say just in leading up to this that there are three basic activities of mankind now that are putting carbon dioxide in the atmosphere. Fuel burning is the one that is of principal concern here.

We include, however, in all our calculations the manufacture of cement. It is only a 2 percent component but, nonetheless, when one calcines limestone and manufactures cement there is a contribution of carbon dioxide to the atmosphere. For the sake of completeness it is in all our tables.

The other one, of course, is clearing of forests, an activity which is of some significance now especially in the tropics.

The tropical forest clearing contribution is on the order of 25 percent of the global total, and it is by no means trivial. Some of the tables in my testimony rank the countries in order of contribution to the atmosphere of CO_2. Brazil ranks 18 if we count only industrial uses of fuel, but if we include their releases from the clearing of tropical forests they rise probably to fourth, although that number is not entirely certain. So that is certainly a major contribution in some countries.

Also, to try to make clear, basically when we are talking about carbon dioxide we are talking about energy use, but obviously all fuels are not equal. It is largely a function of the carbon to hydrogen ratio in the fuels.

On a rough basis, the contributions of carbon dioxide on fuel burning from gas fuels to liquid fuels to solid fuels is as 3 as to 4 and to 5. Again, the numbers are in the text. Gas is strikingly less carbon dioxide at point of combustion than are the other fuels.

I have included in this table wood. Again, this is based simply——

Senator **Wirth**. Which table is that?

Dr. **Marland**. This is Table 1, Figure 1.

I just rationed these out, and roughly it is a ratio of 3 as to 4 as to 5 for natural gas, petroleum liquids and coal, to keep a mental reference.

Now included in this table is wood, and I think many people are surprised to see that wood releases more carbon dioxide per useful energy than do these other fuels. Part of the reason for including it in this table is that if you are going to inventory emissions to the atmosphere, these are the numbers you want to use. You can tally it up at the end of the year how much natural gas was burned and multiply it by 13.78, and you will get a carbon emissions number.

If you are going to compare fuels, however, then these are not the right analyses. One wants to go more into the net emissions through the whole system. For petroleum liquids, for example, it shows here 19.9; but of course, that assumes that you simply burn petroleum liquid.

In order to get petroleum liquids to the point of burning you first explore, drill, pump, refine, transport and a whole variety of processes, all of which have required some fuel consumption and carbon dioxide to the atmosphere. So if we are going to compare natural gas to petroleum liquids, all of these other things should be into the consideration at the point of change.

For wood, although the chemistry of combustion would suggest that it was the highest carbon emissions rate, in fact if we were growing wood on a sustained yield basis the emissions can be virtually zero because we are growing one tree while we are burning another. These are combustion chemistry, but they are not the numbers that one would use in comparing different fuel.

To make this point again, we did a calculation for ethanol from corn. Actually, the numbers in Figure 2 are so terse they may not be useful, but we tried to ask the question as ethanol is made in the United States now from corn, what is the contribution of carbon dioxide.

What you find when you examine the current ethanol system, obviously we can do better if we were dedicated to doing so, but to make ethanol now we run diesel tractors, we make hydrogen fertilizer from methane, we burn coal to get electricity to mill the corn, and all of these things are adding carbon dioxide to the atmosphere even if the corn itself does not.

We grow the corn to take carbon dioxide out of the atmosphere. We make it into ethanol and put the carbon dioxide back. It can be a closed circuit except for all of these subsidies that occur. Even with the subsidies in the current system, the contribution is only 35 percent or so of the direct burning of liquid fuels.

Senator **Wirth**. Wait a minute. Let me see if I understand that. It is only 35 percent. The 22.9 in Figure 2 are the energy inputs?

Dr. **Marland**. This is energy units.

Senator **Wirth**. Are you comparing apples and apples, Figure 2 and Figure 1?

Dr. **Marland**. You have to cross the line to get back to apples on Figure 2. The top part of this is joules of energy per kilogram of ethanol, and in crossing the line those joules of energy are then converted into carbon dioxide.

So for, in fact, a billion joules of ethanol, we would get 15.9 kilograms of carbon, and that is the number that really compares with the preceding table.

Senator **Wirth**. That includes the milling and the conversion?

Dr. **Marland**. That is all the fuel that is burned through that whole process, including running your tractor and manufacturing fertilizer.

The calculation is compounded by the fact that most of these plants do not produce just ethanol, they produce corn syrup and they produce animal feeds. It is not fair to assume that all that carbon dioxide came from the ethanol. Even if there was no ethanol, we still would be giving off some of the carbon dioxide to produce animal feeds when you try to allocate these through.

Our assessment is that the amount of carbon dioxide that you should actually attribute to the ethanol is this 8.1, and I would say, then, that you would compare the 8.1 with the preceding page. Then you are talking about 35 percent.

Does that make sense?

Senator **Wirth**. What is the "therefore'? What is the policy conclusion that comes to that?

Dr. **Marland**. The "therefore 'is even in the current system, ethanol from corn puts into the atmosphere collectively only 35 percent as much carbon dioxide as does petroleum liquids.

Senator **Wirth**. That means what?

Dr. **Marland**. That means we can save two-thirds of the emissions of carbon dioxide by using ethanol as manufactured rather than gasoline.

Senator **Wirth**. That is that we should therefore be encouraging ethanol through various tax measures?

Dr. **Marland**. All other things aside, ethanol from corn as done in the United States, I think we could do better than this if we had a dedicated system. But even in the current system there is a significant savings in carbon dioxide emissions by using ethanol.

There is a risk, I think, in focusing on carbon dioxide to the exclusion of other things. This desk produces no carbon dioxide. It also produces no electricity. You can get down into nitpicking some of these arguments, but the carbon dioxide comparison is a valid one although not well stated here perhaps.

[The prepared statement of Dr. Marland follows:]

Statement of

Gregg Marland

and

Tom Boden

Staff Scientists

Environmental Sciences Division

Oak Ridge National Laboratory

Operated by Martin Marietta Energy Systems, Inc.

for the U.S. Department of Energy

Oak Ridge, Tennessee

Before the

Senate Committee on Energy and Natural Resources

July 26, 1989

Carbon Dioxide Releases From Fossil-Fuel Burning

Mr. Chairman and members of the Committee, I am pleased to be with you to discuss the anthropogenic emissions of carbon dioxide to the atmosphere.

There are three kinds of human activity that are currently resulting in net releases of carbon dioxide (CO_2) to the atmosphere: burning fossil fuels, converting tropical forest area to other land use, and manufacturing cement.

Although it is a comparatively small source of CO_2, cement manufacture involves the calcining of limestone (calcium carbonate) to produce calcium oxide. The associated CO_2 emissions are included in the figures that follow. Production of one metric ton of cement results in the release of 0.136 metric tons* of carbon as CO_2. (This does not count the fuel used in the processing.)

When forest area is cleared and converted to land uses that have smaller inventories of carbon in the biota and in the surface litter and soil, there is a net release of carbon to become CO_2 in the atmosphere. Every cubic meter of timber burned releases about 0.26 metric tons of carbon as CO_2 to the atmosphere, and forest clearing generally results in a release of additional carbon from the soil and surface litter.

When fossil fuels are burned, carbon that has been long stored in the earth is oxidized and released to the atmosphere as CO_2. Because fossil-fuel burning releases heat from the oxidation of both carbon (to produce carbon dioxide) and hydrogen (to produce water), and because the different fuel forms contain different ratios of carbon to hydrogen, the amount of CO_2 produced per unit of energy released is different for the various fuel forms. Figure 1 shows the amount of carbon released as CO_2 per billion joules for average gas, liquid, and coal fuels and shows wood for comparison. It is clear that burning natural gas (mostly hydrogen-rich methane, CH_4) releases less CO_2 per unit of energy than does burning petroleum products or coal.

Care must be used, however, in using the numbers in Figure 1 for comparative purposes. The numbers are based solely on the chemistry of fuel combustion and they can be used to inventory emissions. They do not, however, fully answer the question of how net CO_2 emission rates would change if we were to substitute one fuel for another. For example, petroleum products do not simply appear at the end-use consumer ready for combustion. There is energy consumption (and CO_2 emissions) during the exploration, production, refining, and transport of petroleum products, and all of these emissions need ultimately to be charged against the end-user. Our earlier estimate, based on detailed input-output tables of the U.S. economy in 1974, was that for each billion joules of energy released from petroleum products at the point of end use, there were in fact a total of 23.2 kilograms of carbon released as CO_2 throughout the production-to-consumption system (compared with 19.9 kilograms for the combustion process alone). There are similar, but numerically different, charges to be levied against natural gas and coal, and these numbers will vary with time and place. It is also appropriate to ask how efficiently the different fuel forms (or the generated electricity) can perform a particular task. If, for example, a hypothetical task could be performed more efficiently with coal than with natural gas, then the ratio of CO_2 discharges for coal versus natural gas could in fact be less than suggested by simply comparing the two values in Figure 1.

The inclusion of wood in Figure 1 is also to emphasize that the simple combustion comparison is not necessarily the right one. If fuel-wood is grown in a sustained-yield mode then there is in theory no net emission of CO_2 to the atmosphere. What is released during combustion is the same carbon that was taken up during tree growth, and current combustion is being balanced by current growth. (This assumes that an extra portion of wood is grown to provide the energy for establishing, maintaining, and harvesting the growing trees.)

With this in mind, it is interesting to look at some calculations that Anthony Turhollow and one of us recently did on the manufacture of ethanol from corn (Figure 2). These numbers are based on an average for 1987 practice in the United States, where corn was planted with diesel tractors, fertilized with nitrogen fertilizers produced from natural gas, and milled with electricity typically from coal-fired power stations. The numbers tell us what is being done now and not what could be done if we were to devote ourselves to producing ethanol in the most CO_2-economical way possible. The calculation is complicated by the fact that current ethanol plants generally produce corn syrup and animal feeds in addition to ethanol, and we have to allocate the total CO_2 emissions among the various products. Our best estimate is thus that ethanol is not a CO_2-free fuel but that, at 8.1 kilograms of carbon per billion joules, it still results in only 35% of the CO_2 emissions of direct use of liquids from crude oil. We could undoubtedly do better with dedicated energy crops and/or ethanol from cellulose, but the important point here is that comparisons among fuels should be based on net emissions and that the comparisons can be very complex.

Before presenting numbers for global CO_2 emissions, let us express one more mild caution. Flaring of natural gas, especially gas produced from oil wells in places where there is no infrastructure to collect and use the gas, has been a common practice throughout the world. Although the practice is declining rapidly, as recently as 1983, 43% of the gas produced in the Middle East was flared. Because gas flaring was not an economically important activity, data on gas flaring are not very good or very complete. We have just updated our numbers on CO_2 emissions from gas flaring, and these numbers are now included in the global totals that follow. CO_2 emissions from gas flaring are not included in the individual country and regional summaries presented here. Also note that the sum of CO_2 emissions from all countries would still not give the global total, largely because emissions from ships and airplanes in international commerce are not attributed to any country.

Total CO_2 emissions from changes in land use are subject to considerable uncertainty. The best current estimates suggest that the temperate and boreal zones are nearly in balance but that in 1980 net emissions from forest clearing were resulting in release of 1.8 billion metric tons of carbon per year (range 0.8 to 2.6 billion metric tons) to the atmosphere as CO_2; almost entirely from the tropics. Recent data from Brazil suggest that the current value is likely higher than this. Figure 3 gives the 1980 estimates for the ten countries with the highest rates of tropical forest clearing.

The global total of CO_2 emissions to the atmosphere as the result of fossil fuel combustion (including cement manufacture and gas flaring) amounted to 5.65 billion metric tons of carbon in 1987, up 1.51% from 5.57 billion metric tons in 1986 (Figures 4 and 5). This amounts to approximately 1.1 metric tons of carbon per capita. Most notably from Figure 4, the global total, which stalled briefly in 1974 and dropped again after the oil price shock of 1978-1979, has now risen for four consecutive years and is at its highest level ever. The curve of emissions from the United States has a similar shape (Figures 6 and 7) although the drop after 1979 was deeper and we have not yet surpassed the 1973 and 1979 totals. Preliminary estimates suggest that the 1988 value for the United States will still be below the 1979 peak. These values and those that follow are based on energy statistics from the United Nations Statistical Office and cement statistics from the U.S. Bureau of Mines. Figures 8 and 13 are based on the 1988 UN data tape; all other data herein are based on the 1989 UN data tape.

It is interesting to isolate the data on CO_2 emissions from liquid fuels and an index of the price of oil (Figure 8). The relationship is quite evident, and the net effect has been that from 1973 through 1987, total global CO_2 emissions from liquid fuels increased by only 2%. By contrast, total emissions from gas fuels increased by 47% over this 15-year interval and emissions from solid fuels by 43% (see Figure 5).

Some very sharp contrasts are evident if we group countries by region and compare the growth rates of CO_2 emissions over the last four decades (Figures 9 through 11). Growth rates in North America and Western Europe have been sharply affected by energy policies and prices over recent years, while the developing countries collectively appear to be undergoing growth in energy consumption which is independent of recent changes in energy markets. If, however, we look at individual developing countries, some striking and generally predictable differences emerge between producing and non-producing countries as many non-producing countries have been sharply affected by the increase in oil prices. Although we should be cautious of making too much over one year's increment at the end of a time series, Figure 12 illustrates regional increments for the growth from 1986 to 1987 and shows that developing regions are generally increasing energy consumption (and CO_2 emissions) at greater rates than are the developed regions. Figures 9, 10, and 11 were drawn to the same scale so that the magnitudes of the contributions could be compared.

As a result of these growth differentials, the U.S. fraction of the world total is declining even though its total emissions are increasing. U.S. CO_2 emissions in 1986 were 1.8 times those of 1950 while the U.S. share declined from 42% to 22% of the global total over the same interval (Figure 13). Despite those growth differentials, over half of global CO_2 emissions can still be attributed collectively to three countries (the United States, the Soviet Union, and China). Figure 13 makes clear that although emissions from fossil-fuel burning are dominated by a few countries, and that although there are major differences between countries in emissions per capita, a large number of countries are assuming an increasingly important role.

A number of countries seem to be taking seriously the idea of trying to reduce or offset their emissions of CO_2 from fossil-fuel burning, and there are a variety of ways that have been suggested for pursuing this end. Figure 14 shows data for one country, France, that has already significantly reduced its CO_2 emissions (by 30% since 1979).

In closing, let me add that while data are not yet available to estimate global total CO_2 emissions for 1988, we can use data from the U.S. Department of Energy, Energy Information Agency to make a rough estimate that U.S. emissions for 1988 were more than 3% greater than in 1987.

Thank you, Mr. Chairman.

Acknowledgement: The inquiries summarized here were supported by the Carbon Dioxide Research Program, Office of Health and Environmental Research, U.S. Department of Energy, under contract DE-AC05-84OR21400 with Martin Marietta Energy Systems, Inc.

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[*] Metric tons are used throughout this manuscript. One metric ton is 2205 pounds. To convert metric tons of carbon to metric tons of carbon dioxide, multiply by 3.67.

FIGURE 1

CO_2 emission rates from fuel burning
(kilograms of carbon per billion joules)

Natural Gas	13.78
Petroleum Liquids	19.94
Coal	24.12
Wood	25.32

FIGURE 2

CO_2 emissions associated with production and use of ethanol from corn in the United States - 1987

Energy Inputs	(million joules per kilogram ethanol)
Agriculture	
Direct uses	2.60
Fertilizer	5.68
Other	0.57
Milling and Conversion	14.11
	22.96

CO_2 Output	15.93 kilograms of carbon per billion joules of ethanol
of which	8.14 kilograms is allocated to ethanol (the remainder to other process products such as corn syrup and animal feeds)

FIGURE 3

CO_2 emissions from land use changes in the tropics (1980)
(in millions of metric tons of carbon)

Brazil	336
Indonesia	192
Colombia	123
Ivory Coast	101
Thailand	95
Laos	85
Nigeria	60
Philippines	57
Burma	51
Peru	45
Others	514
Total	1659

From Houghton et al. (1987)

ORNL-DWG 89Z-15257

FIGURE 4

Global total emissions of CO_2 to the atmosphere as a result of fossil fuel consumption, cement manufacture, and gas flaring. (Billions of metric tons of carbon.) (See data in Figure 5.)

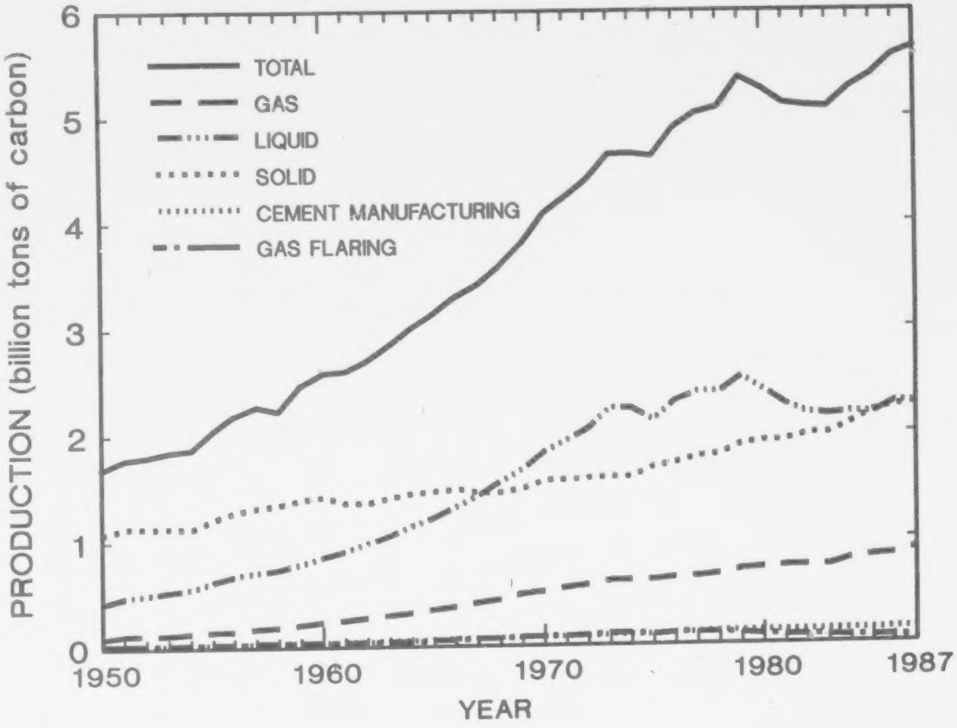


FIGURE 5

Global total emissions of CO_2 to the atmosphere as a result of fossil fuel consumption, cement manufacture, and gas flaring. (Millions of metric tons of carbon.) (See graph in Figure 4.)

Year	Total CO_2 from fossil fuel consumption, cement manufacturing, and gas flaring	Gas	Liquid	Solid	Cement manufacturing	Gas flaring
1950	1638	97	423	1078	18	23
1951	1775	115	479	1137	20	24
1952	1803	124	504	1127	22	26
1953	1848	131	533	1132	24	27
1954	1871	138	557	1123	27	27
1955	2050	150	625	1215	30	31
1956	2185	161	679	1281	32	32
1957	2278	178	714	1317	34	35
1958	2338	192	732	1344	36	35
1959	2471	214	790	1390	40	36
1960	2586	235	850	1419	43	39
1961	2602	254	905	1356	45	42
1962	2708	277	981	1358	49	44
1963	2855	300	1053	1404	51	47
1964	3016	328	1138	1442	57	51
1965	3154	351	1221	1468	59	55
1966	3314	380	1325	1485	63	60
1967	3420	410	1424	1455	65	66
1968	3596	445	1552	1456	70	73
1969	3809	487	1674	1494	74	80
1970	4090	515	1838	1571	78	87
1971	4241	553	1946	1571	84	88
1972	4409	582	2056	1587	89	95
1973	4647	607	2240	1594	95	110
1974	4655	615	2244	1591	96	108
1975	4628	620	2131	1686	95	95
1976	4894	644	2313	1723	103	111
1977	5033	645	2390	1786	108	105
1978	5082	673	2383	1802	116	107
1979	5365	713	2535	1899	119	100
1980	5263	724	2409	1921	120	89
1981	5129	734	2272	1930	121	72
1982	5097	732	2181	1993	121	70
1983	5088	735	2166	1998	125	63
1984	5263	796	2194	2088	128	57
1985	5382	826	2175	2196	130	56
1986	5565	845	2281	2250	136	54
1987	5650	895	2287	2276	140	50

FIGURE 6

Emissions of CO_2 to the atmosphere from the United States as a result of fossil fuel consumption and cement manufacture. Emissions from gas flaring are not included. (Billions of of metric tons of carbon.) (See data in Figure 7.)

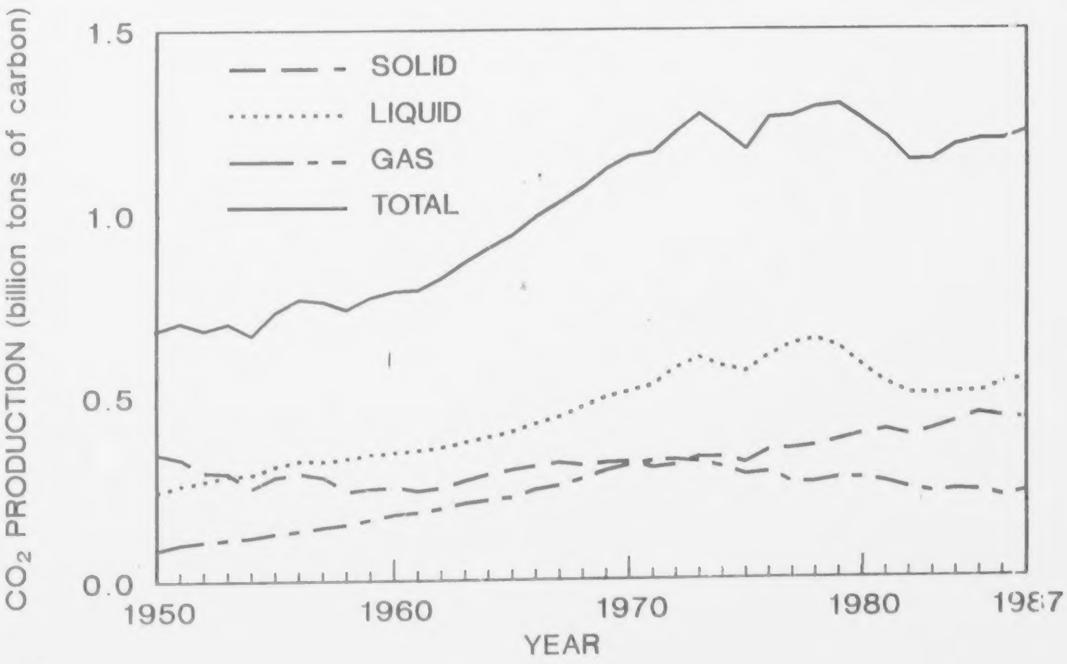


FIGURE 7

CO_2 emissions in the United States as a result of fossil fuel consumption, cement manufacture, and gas flaring. (Millions of metric tons of carbon.) (See graph in Figure 6.)

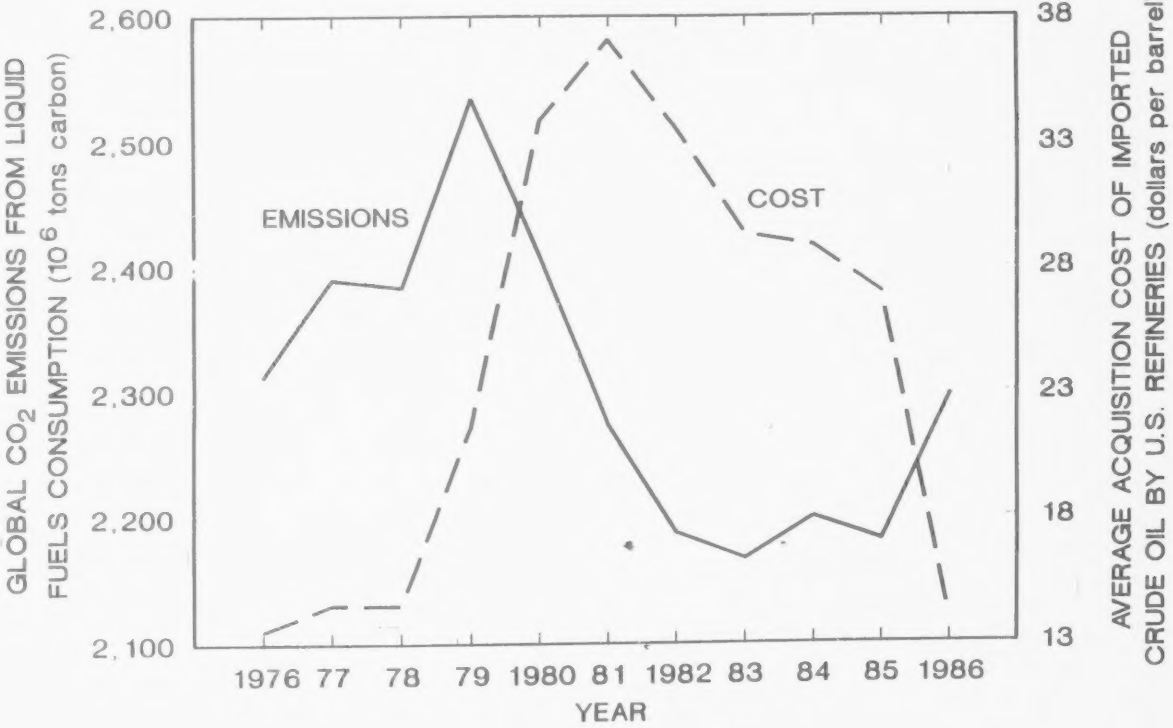
Year	Total CO_2 from fossil fuel consumption and cement manufacture (does not include gas flaring)	Gas	Liquid	Solid	Cement manufacture	Gas flaring
50	684	87	245	347	5	12
51	705	103	262	335	6	12
52	686	110	273	297	6	12
53	703	116	287	294	6	12
54	670	121	290	252	6	11
55	735	131	313	283	7	11
56	769	138	329	295	8	13
57	763	148	326	283	7	12
58	742	156	333	245	8	9
59	773	170	343	252	8	8
60	791	180	350	253	8	8
61	794	187	354	245	8	8
62	825	199	364	254	8	6
63	870	210	379	273	9	6
64	908	220	390	290	9	5
65	994	228	406	301	9	5
66	944	246	426	313	9	6
67	1032	259	444	321	9	7

FIGURE 7 (Continued)

Year	Total CO_2 from fossil fuel consumption and cement manufacture (does not include gas flaring)	Gas	Liquid	Solid	Cement manufacture	Gas flaring
68	1074	277	472	315	10	8
69	1125	298	497	320	10	8
70	1159	312	515	322	9	7
71	1169	323	530	306	10	4
72	1224	328	576	310	10	4
73	1272	322	605	334	10	4
74	1229	308	581	330	10	2
75	1177	286	565	318	9	2
76	1260	291	608	352	9	2
77	1268	261	642	356	10	2
78	1291	265	655	361	11	2
79	1299	275	635	379	11	2
80	1258	273	581	395	9	2
81	1209	264	533	403	9	1
82	1146	245	502	390	8	1
83	1148	234	500	405	9	1
84	1186	241	507	428	10	2
85	1200	237	506	448	10	1
86	1201	223	531	438	10	1
87	1224	235	544	434	10	2

FIGURE 8

Global total CO_2 emissions from liquid fuels compared with an index of the cost of crude oil over the period 1976 through 1986.



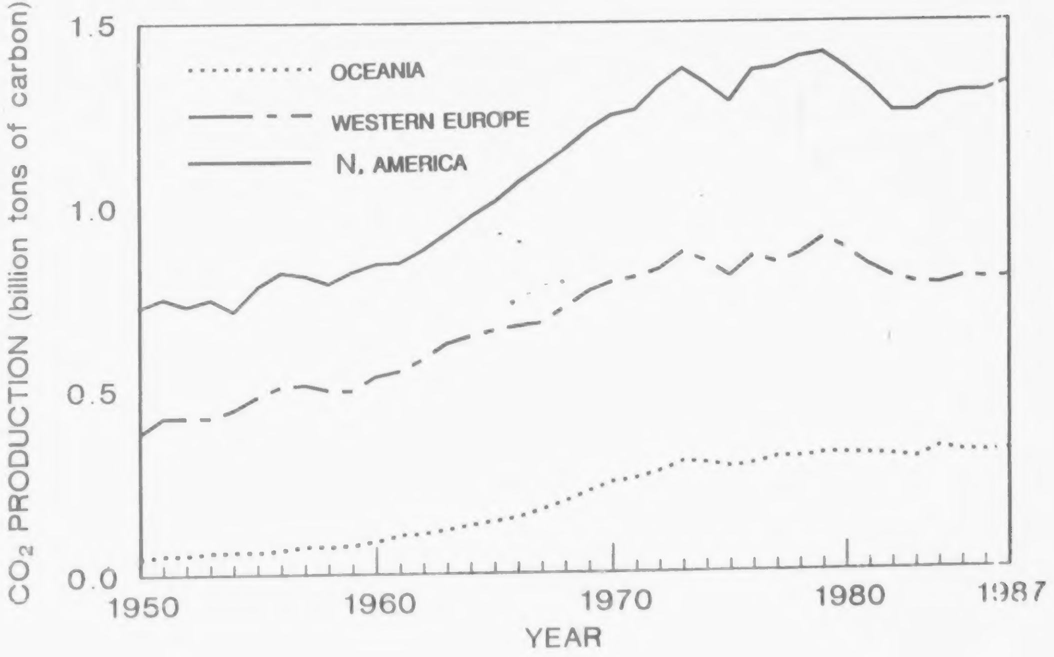


FIGURE 9

Total CO_2 emissions from fossil fuel consumption and cement manufacture from North America (United States plus Canada), Western Europe, and Oceania (Australia, New Zealand, Japan, and other nations of the South Pacific Region). (Billions of metric tons of carbon.)

FIGURE 10

Total CO_2 emissions from fossil fuel consumption and cement manufacture from the centrally planned economies of Europe (USSR and Eastern Europe) and the centrally planned economies of Asia (China, North Korea, Vietnam, etc.). (Billions of metric tons of carbon.)

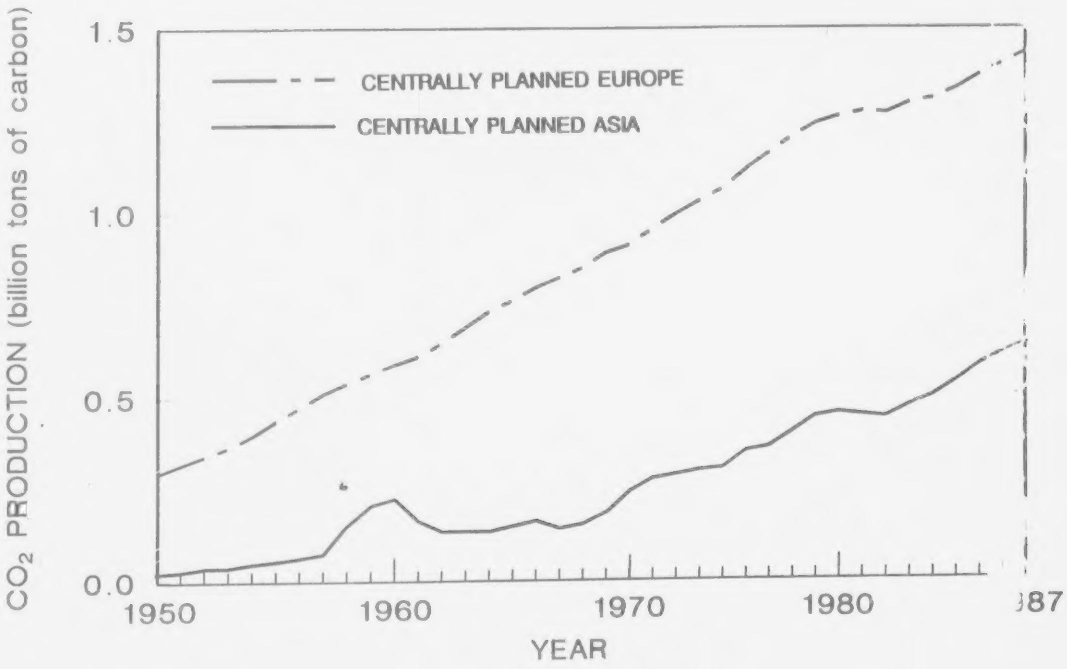


FIGURE 11

Total CO_2 emissions from fossil fuel consumption and cement manufacture from the developing countries of the Middle East, Latin America, South and Southeast Asia, and Africa.

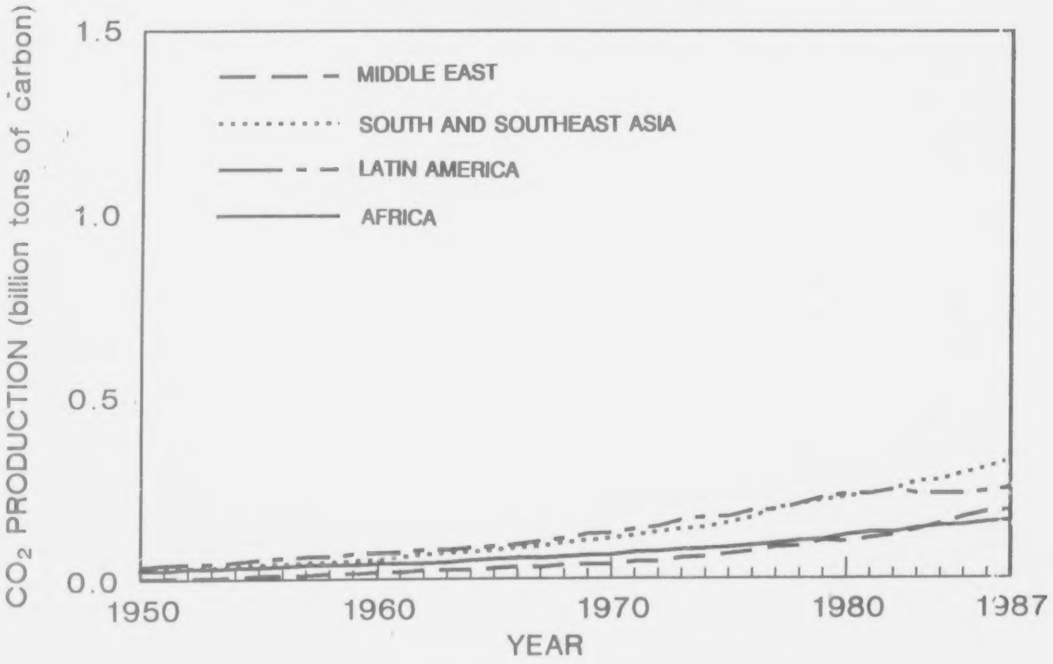


FIGURE 12

Percentage change in CO_2 emissions from 1986 to 1987 for selected countries, global regions, and the world as a whole. Emissions are those from fossil fuel consumption and cement manufacture but do not include those from gas flaring. Since global total gas flaring decreased from 1986 to 1987, the growth rate for world total emissions shown here at 1.59% is slightly greater than when gas flaring is included - 1.51%. (See text.)

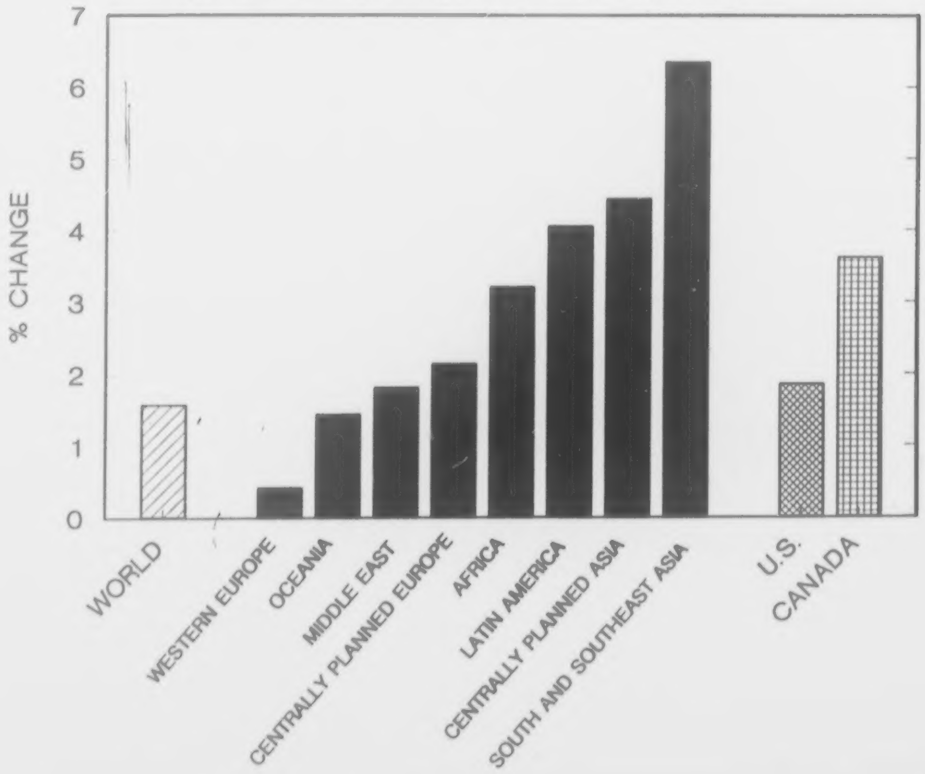


FIGURE 13

CO_2 emissions, by country, for 1950 and 1986, both as a percentage of the world total and as a per capita value. Emissions from gas flaring are not included. Per capita emissions are in metric tons of carbon per person (population data from UN Statistics Office). Numbers at the extreme left show the ranking of countries in 1986, while numbers in parentheses show ranking in 1950.

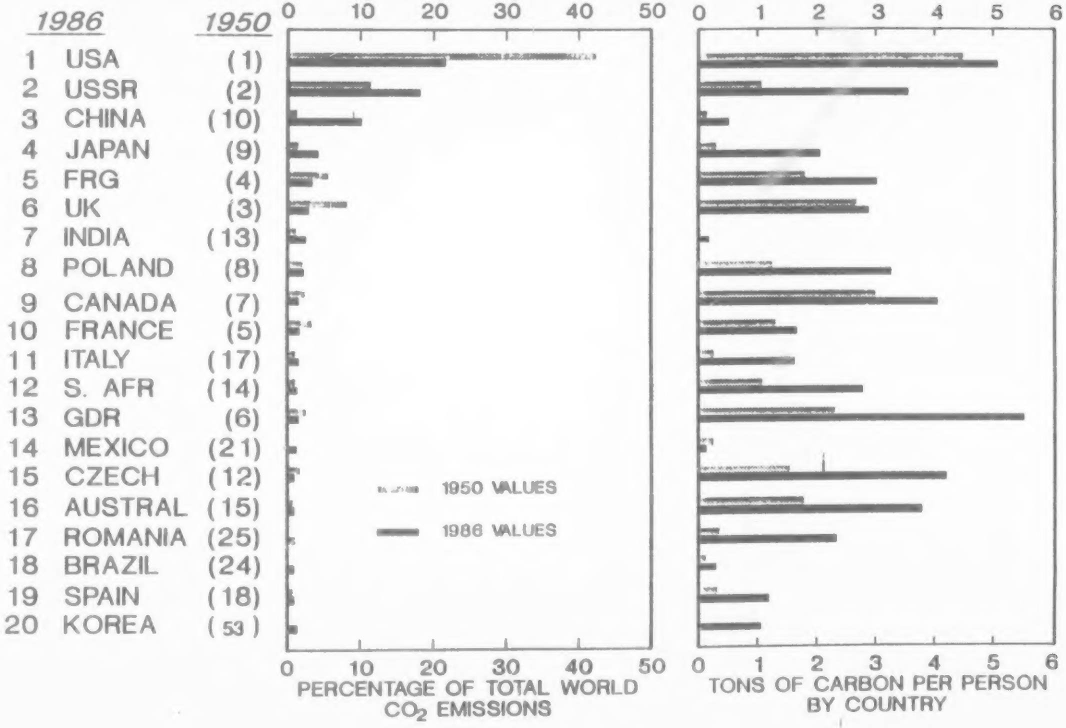
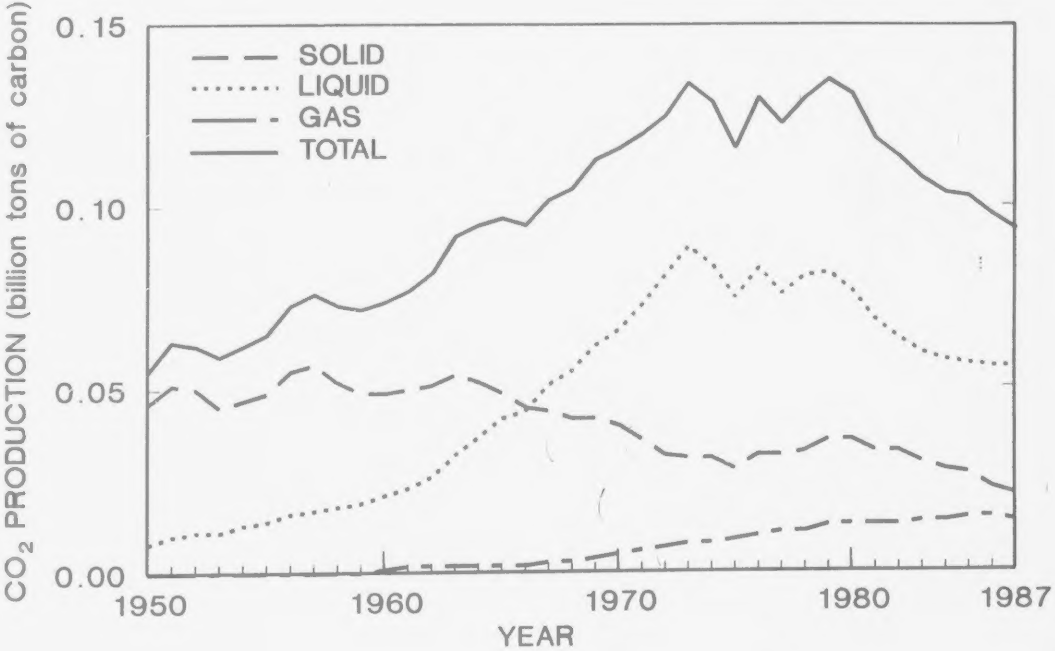


FIGURE 14

Emissions of CO_2 to the atmosphere from France as a result of fossil fuel consumption and cement manufacture (Billions of metric tons of carbon.) (Scale is 1/10 that of Figure 6.)



Senator **Wirth**. I am trying to figure out what is compared to what.

Dr. **Marland**. The other things that enter into this, and these are sort of side issues, because basically what I present to the rest of this is carbon emissions numbers. It is a calculation which is not really difficult to do, but the data are not very good. It is like sticking a thermometer out and measuring the temperature.

So there is a lot that goes into this, and I do not want to belabor that except to say we claim accuracy with these numbers on the order of 10 percent, but I believe the time series is better than that. Comparing the 1986 number to the 1987 number, we are not having a 10 percent problem. With the 1987 number as an absolute value, plus or minus 10 percent is not an unreasonable expectation.

That is for the global total. Obviously in the United States we should be able to do better than that. In Africa, you worry about the data.

You will see numbers from other sources which differ slightly, and there are a variety of reasons for that. One is how one treats nonfuel uses of liquids. Obviously there is some oil which is "used" but it ends up as asphalt on streets and does not produce carbon dioxide.

We also have the problem of fuel that goes in the international transport. If a jet plane is fueled in New York and flies to London, who do you charge that fuel to? In the calculations we have done, it gets charged to no one. It shows up in the global totals, but it is not charged against the United States.

So if you add up all the countries in this data, you will not get the world total.

Senator **Wirth**. Which figure are you talking about?

Dr. **Marland**. That is sort of pervading all through this. The point is we can get all of the countries, but you cannot add them up and get a total.

The numbers that I am going to show for the global total, Figure 5——

Senator **Wirth**. Let us go back to Figure 3. What does Figure 3 mean, CO_2 emissions with land use changes?

Dr. **Marland**. This is largely tropical forest clearing. The best estimate is that we are talking about something like 25 percent of the global total coming out of clearing tropical forests. The forests in the temperate——

Senator **Wirth**. What is the total annual carbon dioxide production? Is it about 6?

Dr. **Marland**. 5.6 billion metric tons.

Senator **Wirth**. You are saying a little more than a quarter of that——

Dr. **Marland**. That is emissions from fuel use. If you really wanted a total, you would have to add this to it. This is in addition.

Senator **Wirth**. That is fuel use only, 5.6?

Dr. **Marland**. Right.

Senator **Wirth**. Land clearing is another almost 17?

Dr. **Marland**. Right. Actually 18, 1 from the temperate zones and 17 from the tropical zones. This does not even include the temperate zone. It is a very small contribution.

Senator WIRTH. By the way, how do you measure that? How do you measure how much carbon dioxide is produced from land clearing?

Dr. MARLAND. This is one of the great arguments that is going on now, and you will find quite a range of estimates. Basically it is an attempt to measure how much forest has been cleared, when it was cleared, how much carbon, how much standing mass of biomass was on that land before it was cleared, and if you burned it how much was actually oxidized or went into other uses.

It is three numbers: how much was cleared; how much carbon was there; and what happened to the carbon when you cleared it.

This is probably a conservative number from Brazil. This is abased on 1980 tropical forest clearing, and Brazil has accelerated since then. People are just starting to bring together the satellite photography to try to analyze this in a systematic way. The indications are this number will creep upward as the numbers become better.

Senator WIRTH. The number should be significantly higher in 1985 and 1986.

Dr. MARLAND. At least for Brazil, yes.

The challenge, of course, is knowing how much carbon was there when the forest was cleared. If it was a virgin forest, had the forest already been degraded by harvesting some of the timber, what was the status of the forest when it was cleared.

Senator WIRTH. These estimates were made from satellite photography?

Dr. MARLAND. These estimates are largely based on the UN Food and Agriculture Organization. They did a survey in 1980 and tried to get responses from most of the tropical countries as to what is the rate at which your tropical forest is being cleared. Refinements of this are being done now trying to use satellite photography, but there is in fact very little of that in the numbers that you see here.

Senator WIRTH. Each of these countries would probably have incentive to underestimate that if they are reporting that, would they not?

Dr. MARLAND. Yes. The UN data is an interesting phenomenon. The data we worked with in some offices of the United Nations, they basically report the data as it comes to them from the countries. Other offices within the United Nations, if they do not like the number that is reported to them from the country, they go out to other sources and try to put their best estimate on it.

All of the carbon dioxide emissions numbers in here are based on numbers in the United Nations statistical office. The Energy Statistics Office of the UN does use their best judgment to try to upgrade numbers that they get from countries. So at least in that office there is an effort to do the best they can. There are other UN offices that, as I say, simply accept what is reported.

Senator WIRTH. The purpose of Table 5 is to demonstrate cement manufacturing?

Dr. MARLAND. Table 5 is the sum total as a time series since 1950 of what is going out from fuel use, cement manufacture and the flaring of gas at oil fields.

Senator WIRTH. Your 5.65 is right here.

Dr. MARLAND. That is the 5.65 million tons.

I should point out that if you are counting pages, your copy has no page 12 unless you got the draft that went out yesterday.

Senator Wirth. I have no page 12.

Dr. Marland. It was censored by me.

Senator Wirth. That is a good thing to hear.

Dr. Marland. We will supply a complete copy. The gas flaring data was just put into this file last week, and I had a computer plot for Figure 12 that I was looking at on the airplane, and it just was not satisfactory. So I figured it was better to destroy it than have an unsatisfactory plot.

Senator Wirth. You did that voluntarily without any help from OMB.

Dr. Marland. Absolutely. The guy next to me on the plane helped a little.

The complete data set is in Figure 5.

The graph unfortunately is useful to have because if you look at the graph you get more of a flow, and it becomes fairly obvious that emissions were rising rather continuously up until about 1973. With the oil crisis of 1973, there was no increase to 1974, and when the oil price shocks of 1978 and 1979 hit, carbon dioxide emissions started down again.

They bottomed out in 1983, and for the last four years they have started heading back up again. They are now at the highest levels ever, and we are on an increasing track.

Senator Wirth. The total line of Figure 6——

Dr. Marland. Figure 6 is the United States. The total line in Figure 6, this is emissions from the United States.

Senator Wirth. It is higher than it has ever been before?

Dr. Marland. Figure 4, the world total, is the highest. The U.S. is not. The world total reached a minimum——

Senator Wirth. Figure 4 is the one that is gone?

Dr. Marland. Figure 4 is the one that is gone. You have to track down the first column of Figure 5. It reached a peak in 1979, dropped for three years as the oil price went up and bottomed out in 1983 and started back up again.

Basically, you see the exact same thing in Figures 6 and 7 for the United States, except the drop was deeper and the recovery is slower. So the United States is not yet back to where it was in 1979.

Senator Wirth. Total emissions, billions of metric tons. This is not a percentage of anything else? This is total figures by the U.S.?

Dr. Marland. Absolute values. It shows the emissions from solid, liquid and gaseous fuels. Cement is also inherent even though you cannot see it. It is a very small 1 percent across the bottom of the graph.

At Mr. Horowitz's request, I took a shot at guessing where 1988 will be. It takes a year for the UN to get the data compiled, so we cannot do it for the world. For the U.S., my guess is that the number will be about 3 percent bigger in 1988 than it was in 1987, but it will still be below the 1979 peak. We are still creeping back up toward that.

Again, Figure 7 is the value of the tables that are plotted in 6. Just as an aside on Figure 6, if you calculated where in the U.S. economy these emissions come from, 32 percent of it comes out of electric utilities. If you take that 32 percent from the electric utilities and say, okay, how much electricity is used in residential commercial and industrial and then calculate just for the industrial, the residential commercial and the transportation, they are roughly equal. Roughly a third of the U.S. emissions come from each of those sectors.

Transport is actually a little bit below a third. The residential commercial is a little bit above a third. Industrial is almost exactly a third of emissions in the United States.

Senator WIRTH. So there is a rule of thumb, you say, that about 400 million tons comes from residential, 400 million tons from industrial and 400 million tons from transportation? Is that about right?

Dr. MARLAND. That would be very close. That is taking electric power and allocating it to where it is ultimately used.

Senator WIRTH. That is just from electric power generation?

Dr. MARLAND. No, that is everything.

Senator WIRTH. What we do in transportation in a year is about the equivalent of what Brazil does clearing its rain forest?

Dr. MARLAND. Yes. Very close.

Senator WIRTH. That is an interesting "gee whiz" figure, is it not?

Dr. MARLAND. Yes, it is.

Another comment on the U.S., just for thought, is that the per capita emissions is about 5 tons per person. These are again metric tons. That is a lot of carbon.

The last issue of the Sierra Club bulletin, whatever it is called, had a piece where they tried to calculate where my 5 tons comes from. He was able to calculate how much electricity do I use to heat my house, how much gas do I use in my car and ends up accounting for about one-third of that 5 tons. Then he called me and said where is the other two-thirds. The answer, of course, is the other two-thirds is the energy that was required to manufacture his car and the energy that went into manufacturing his wardrobe and his contribution to the U.S. military and to the U.S. Government and those sorts of things.

Roughly one-third of the individual contribution is something over which one has direct control.

Senator WIRTH. You have it broken down as to individuals?

Dr. MARLAND. I have a student this summer who is trying that. I would like to sort out what percentage of our emissions come from agricultural activities, what percentage of it can we attribute to specific industries. I am not sure that helps us, but certainly if we are going to go in and try to solve it, it gives the target points, the places that give the biggest bang for the buck.

Senator WIRTH. What does the average automobile weigh? If you drive around, do you produce carbon dioxide about the equivalent of the weight of your car in a year?

Dr. MARLAND. I have not done that arithmetic, but that is the number that I——

Senator WIRTH. 5 million tons, 10,000 pounds.

Dr. MARLAND. You are thinking faster than I.

Senator WIRTH. I do not know. How much does a car weigh?

Dr. MARLAND. We have a vote for 3,100.

Senator WIRTH. I have heard this figure, too. You produce the weight of the car every year in carbon dioxide.

Dr. MARLAND. That is close. That is going to be close.

The thing that one has to be careful about in carrying these numbers around is that sometimes you see it in carbon dioxide, and I always keep track of the carbon. When you have to worry about the oxygens that happen to be attached to it, it makes it easier to move from coal to the atmosphere and back to trees. If you want to do these numbers in carbon dioxide, then you multiply by 3.67. It seems simpler to stick with the carbon and not get caught with those.

But yes, I think that sounds very close.

Senator WIRTH. I can see the headline now. Taxpayer-subsidized study confirms Detroit's poisoning of atmosphere.

Dr. MARLAND. 5 tons per person.

Figure 8 is two plots superimposed. One is emissions globally from liquid fuels only, and the other one is the cost of liquid fuels or an index thereof. It is rather striking, at least from this interval from 1976 to 1986 that as the cost of liquid fuels goes up, the emissions from liquid fuels go down. It is a really quite remarkable correspondence.

The net effect of this is that because of the price increases since 1973, the emissions from liquid fuels have been virtually static since 1973. They have gone up something like 2 percent.

Most of the increase in emissions in 1973 have been solid and gaseous fuels which have not experienced these same extreme movements of price.

So I guess the "therefore" of that is that price changes can control emissions, so basically they have driven conservation.

In Figures 9, 10 and 11 I have separated the earth into geographic political regions and plotted the growth in carbon dioxide emissions since 1950. Figure 9 has basically Western Europe, North America and——

Senator WIRTH. What does Figure 8 tell you? If you were sitting up here, what would you conclude from Figure 8 in terms of what we ought to do?

You heard Secretary Watkins' testimony earlier.

Dr. MARLAND. I am very reluctant to say what we ought to do. On the other hand——

Senator WIRTH. If you are concerned about carbon dioxide and there seems to be a very, very sharp correlation between the cost of liquid fuels, the use of liquid fuels and the production of carbon dioxide, you would therefore conclude that if you want to do something from purely scientific data, forget what the economists are saying——

Dr. MARLAND. That is right. The cost goes up; use will go down.

Senator WIRTH. Cost goes up; use will go down. If you were to therefore put a significant tax on liquid fuels, all our knowledge tells us over quite a long period of time that the production of carbon dioxide would therefore go down quite significantly.

Dr. MARLAND. I think that is something it concludes. Of course, in this case when that cost increase simply impacted the liquid fuels, people would slip back and forth into this fuel switching. If you did that on all carbon-based fuels, it is not clear what would happen, I guess. It is a tough one.

Senator **Wirth**. You would switch over to coal. If the price of oil went up very sharply, people would switch to coal and then you might have just the opposite. Because coal produces more carbon dioxide, you might by raising prices have accomplished the wrong thing.

Dr. **Marland**. That is right, unless you raise the prices in proportion to the carbon contribution. If you raise the price of coal more than the price of oil, more than the price of gas, then just presumably you would tilt things in the direction you wanted it to go.

Senator **Wirth**. Presumably, therefore, the result of that would suggest that you would price fuels based upon if you are going to use the economic argument that we are talking about at the end of the hearing with Secretary Watkins. If you price things on the basis of how much carbon dioxide they produce, the external effect of the use of that energy, that would be the optimal environmental policy to pursue, not just a straight tax on one fuel or another but some kind of a tax that was related to carbon.

Dr. **Marland**. Related to the carbon content.

Senator **Wirth**. Has anybody ever done anything like that? What are the implications of Figure 8 for examining, say, a carbon tax?

Dr. **Marland**. I cannot answer that. I think there are analyses that have tried this sort of thing. This kind of thing has been done.

The challenge, of course, harkening back to some of my earlier comments, is not to do it simply on the combustion chemistry but it has to take consideration of all those net carbon dioxide emissions and not just the emissions that occur in final consumption.

I talked to a fellow from Tokyo Electric not too long ago, and again I have not checked his arithmetic but his feeling was that imported LNG ended up to be about the same as domestic petroleum by the time you invested the energy consumption of compressing the gas and transporting it.

So you would have to make sure that you did not do those kinds of things inadvertently, tip the balance in the wrong places.

Figures 9, 10 and 11 are just visual, really. Figure 9 is developed economies with North America on top. This is simply U.S. and Canada. Oceana is Australia, New Zealand, Japan and all of the South Pacific nations and, of course, Western Europe. These are all areas with fairly high emissions rates but relatively low growth rates now.

By contrast in Figure 10, the centrally planned economies of both Europe and Asia have relatively high growth rates. Of course, Asia is mostly China. In fact, Eastern Europe is now larger than North America in total emissions.

Senator **Wirth**. Figures 9, 10 and 11 are really functions of the economic growth?

Dr. **Marland**. Right.

Senator **Wirth**. These tell you that looking at Figure 10, if China at the bottom of that chart continues to grow as rapidly as it has, that number is going to go up very dramatically. Is that right?

Dr. **Marland**. That is absolutely correct.

One of the things I would like to do with this and have not had a chance is sort out population growth.

Senator WIRTH. What happens when India's population catches up with China, as people have suggested it is going to, and India accelerates its economic development?

Dr. MARLAND. India is in Figure 11 as part of South and Southeast Asia. You can see that it is relatively low now, but the slope is quite steep and the growth rate is very high for South and Southeast Asia.

Senator WIRTH. That is where the big ticket numbers are.

Dr. MARLAND. These are hard, I think, and these are all drawn to the same scale, these three plots, to capture the idea that although the growth rates are very high in some of these other areas that, still, the highest absolute values are indeed North America, Western Europe and Eastern Europe.

So into the future, yes, these developing countries become major actors, but as the situation stands today we still get 50 percent of total emissions from only three countries, the U.S., USSR and China.

U.S. share is now in the order of 22 percent of the world total, having been as high as 42 percent when this time series began. That is because the other countries are growing much more rapidly. We still are as a country the largest single component.

I had some qualms in Figure 12 about simply taking one year at the end of the time series and making very much out of it, but yet I think this gives some feeling for what is happening.

You may be aware the British press has gotten a few of these numbers and has been having a bit of a good time in comparing what is happening in the UK versus France and West Germany. I think they have made more than is justified over one year's data.

Senator WIRTH. That is Figure 13?

Dr. MARLAND. Figure 12 is what I was really referring to. Western Europe has a very low growth rate from 1986 to 1987. It is only .4 of a percent. When you sort that out by individual countries, however, it turns out both France and West Germany have gone down where the UK is up rather significantly.

Again, that is just one year's data sequence. If you go across this, you see a rather dramatic rise in Canada as well. Of course, the U.S. was above the world average in that year from 1986 to 1987.

The biggest jump was in South and Southeast Asia. As a general rule, the developing countries have higher growth rates now than do the developed countries.

Senator WIRTH. There is no reason to believe that is not going to continue and, in fact, compound itself.

Dr. MARLAND. I agree.

Senator WIRTH. Those curves have gone up very dramatically. So we could sit and be the best people in the world in terms of carbon dioxide and level off and drop our carbon dioxide emissions, and we would be totally overwhelmed and overtaken by what the Indians and the Chinese are doing.

Dr. MARLAND. Absolutely. Population is intimately intermixed with this.

One of the things I wanted to do and have not yet had a chance to do is try to sort out for these developing countries how much of that increase in CO_2 emissions is truly an increase in personal energy consumption and how much of it is simply due to the increase of population. I suspect it is mostly the latter.

Senator **Wirth**. When you say the British press had gotten hold of numbers, which numbers were you talking about?

Dr. **Marland**. What they got was the change from 1986 to 1987.

Senator **Wirth**. This is on Figure 12?

Dr. **Marland**. Yes.

Senator **Wirth**. You have this broken down somewhere by country?

Dr. **Marland**. Yes.

Senator **Wirth**. How do you get to the bar charts here?

Dr. **Marland**. Just added up all of Western Europe.

Senator **Wirth**. We do not have that data.

Dr. **Marland**. I can give it to you. I have it with me.

Senator **Wirth**. That is okay. I was looking through the tables and could not find it.

Dr. **Marland**. It has been an interesting experience. My own guess is that they made up the numbers and then called me on the phone and asked me to confirm them. They kind of caught me dumbfounded, and I did. It was interesting.

They had the 1986 numbers. I think they guessed at the 1987 numbers and called me on the phone.

There is an article in the New Scientist in which some of the numbers are right and some are wrong. They are not numbers that they got from me, although it does have my attention. It is a very interesting thing.

Senator **Wirth**. Why are they going this way and the French and Germans are going the other?

Dr. **Marland**. The French graph, Figure 14 in here, is really rather clear as to what is happening in France. It is the one country which has had significant reductions, and for whatever one thinks of the French nuclear program, France is now generating 76 percent of their electricity with nuclear power and another 20 percent with hydro. Since 1979, carbon dioxide emissions have been decreased by 30 percent.

Senator **Wirth**. You put this table in here for Senator Johnston?

Dr. **Marland**. And for you.

It is a striking example of one that is going in that direction.

Senator **Wirth**. Why did the Germans go down?

Dr. **Marland**. Germany is a mixture. It went down a relatively small increment. I will give you the graph. I think it is a mixture of things. They are importing electricity from France. France has an excess generated capacity. They are sending electricity to West Germany and the UK. Apparently it was a relatively mild winter.

Senator **Wirth**. That means the UK's figure would be going down, too.

Dr. **Marland**. Their coal consumption has been going up.

Senator **Wirth**. Both Germany and the UK are buying electricity from France, but Germany is going down in terms of its carbon dioxide production and the UK is going up, so something else is going on.

Dr. **Marland**. Something else is going on in the UK. It is not a totally fair comparison. Here is the UK since 1950. France is, of course, the graph you have, and West Germany. Viewed on a longer time scale, the differences between the graphs are not that dramatic that you would want to make a big deal about what was happening over the last year.

Senator **WIRTH**. Certainly the trends are instructive. Something is happening. If the Germans are going this way and the U.S. is going up as you suggest, pretty startling, something is happening in the dynamics of the way in which our economies are working and the way in which our societies are viewing energy.

Dr. **MARLAND**. That is correct.

Senator **WIRTH**. What in a broad sense do you think the differences are?

Dr. **MARLAND**. I think that is stepping too far from the things I feel comfortable with here.

Senator **WIRTH**. Why are the Germans going down, and why are they buying electricity from France? What else might they be doing to keep their trend in the downward direction?

Dr. **MARLAND**. It is not that different since 1973 in the U.S. curve. For the last year they are importing electricity from France. They are importing natural gas from the Soviet Union or some of the low countries. Apparently they had a mild winter last year. This is part of what I am saying. We have not really had a chance to look through all this data.

Yes, it is tailing off at the end where the U.S. is starting up now.

Senator **WIRTH**. What is the German per capita? The U.S. per capita production of carbon dioxide is 5 million tons?

Dr. **MARLAND**. Right.

Senator **WIRTH**. What is the German per capita production of CO_2?

Dr. **MARLAND**. Just short of 3 million tons.

Senator **WIRTH**. What is the Japanese?

Dr. **MARLAND**. Just about 2 million tons. This is Figure 13. The highest two per capita are East Germany and Luxembourg. They are countries that are very industrialized and very heavily dependent on coal. This is the top 20 countries for CO_2 emissions now from fossil fuel burning.

Senator **WIRTH**. Tons of carbon per capita, East Germany is?

Dr. **MARLAND**. About 5.5, 5.4.

Senator **WIRTH**. Doing more per capita than we are?

Dr. **MARLAND**. Right.

Senator **WIRTH**. Now you say the Japanese are doing less than half of what we are?

Dr. **MARLAND**. Right.

Senator **WIRTH**. Part of that is a more efficient economy in terms of energy usage but also different kinds of patterns in the way in which their people live in terms of housing. A third of our 5 million tons is domestic and commercial usage. Presumably the Japanese are significantly more efficient there than we would be; right?

Dr. **MARLAND**. The contribution from transportation is significantly less in Japan as well. Japan is 2.1 per capita, France is 3.8, West Germany is 3.1, and Canada is 4.1.

Senator **WIRTH**. Is 3 percent a real figure in the U.S.? Are you pretty confident of that 3 percent?

Dr. **Marland**. For 1987 to 1988? No. All the numbers in here are based on United Nations data. To move to a 1988 number, the United Nations simply has not released the data yet. You have to move into DOE data. It is very difficult to get a match.

Senator **Wirth**. Can you do DOE data in the U.S. for 1987 to 1988; 1985, 1986, 1987 and 1988?

Dr. **Marland**. What I tried to do is use the DOE data to calculate 1986 and use the 1986 data to estimate 1987 and then using the real data for 1987 estimate 1988. I did a very poor job of estimating 1987 from the 1986 data. My estimate was much too high.

Senator **Wirth**. They do not know for sure that U.S. carbon dioxide production per capita has gone up sharply in 1987 and 1988.

Dr. **Marland**. The 1987-1988 rise will be bigger than 1986 to 1987.

Senator **Wirth**. The 1986 to 1987 rise is 1.5 percent?

Dr. **Marland**. 1.8, almost 1.9. The 1987 to 1988 will be bigger than that.

Senator **Wirth**. That is a very significant rise to go up 1.8. It will go up higher than that?

Dr. **Marland**. Basically, we went in the trough after 1978 to 1979 when the oil prices went up and we dropped off in energy usage. The trends looked to me like whatever that inspired in terms of conservation and energy economics that that has ended, and we are starting on an upward swing again.

Senator **Wirth**. You cannot tease out where those increases are from the three groups that you have, transportation, industry and——

Dr. **Marland**. We are going to try. We have not had a chance to do that. This is, as you might guess, a huge data set that we mess with, and we make progress slowly.

Senator **Wirth**. It seems to me it is very difficult, and it is not your business, it is ours.

We were talking to the Secretary earlier about U.S. leadership. It is very difficult for us in the United States to make an argument that everybody else should be dropping carbon dioxide emissions when we are in a very sharply increasing path upward.

Could I come to that conclusion, that we are on a sharply increasing path upward?

Dr. **Marland**. I think we are definitely turning back up. It dropped in the early 1980s, and we are on an increase now.

Senator **Wirth**. We went with a group to Brazil in January and talked with President Sarnay. He said two things: First, that we do not want the Amazon to become a green Persian Gulf.

The second thing he said was why are you coming here telling us about our rain forest when you are ripping down your own. He obviously had been prepped about the Tongass and what we are doing there, but it is the same kind of a leadership issue.

Dr. **Marland**. That is right. I was very struck. This gets out of my realm again, but I was struck listening to the exchange between you and the Secretary. I really do not disagree with anything he said.

I have given a lot of thought to what one might do, and the last time I talked to you was about planting trees. You can do the arithmetic on what the other options are and where one might go, and there are not many easy answers.

It is not like the chlorofluorocarbons. You can envision a solution to that, but there is no easy answer. Anything that we do to solve this carbon dioxide is going to be painful in terms of lifestyle and economics. If there were easy answers, you can try them and we would be pushing along that way.

Senator WIRTH. You have to think very aggressively about alternatives and very aggressively about conservation. It seems to me that those are not easy answers but they are very real ones. I can tick off a number of things that you do right away that do not put people over the edge, conservation being one of those and a whole variety of things that we could do quite easily. Planting trees is something that you could do and do quite easily; alternative energy programs, looking at solar.

Dr. MARLAND. I hope the message sneaked through in here, too, trying to do it kind of subliminally. I think the potential for biomass fuels is fairly significant. We can do something with alcohol fuels or direct burning of wood.

Senator WIRTH. It becomes very interesting to look at that as a possibility. It should be very encouraging.

Are there other areas like ethanol?

Dr. MARLAND. There are little bits of work taking place here and there and direct burning of wood for electricity generation. I think it is very promising. Burning the plantation forests on a sustained yield basis, harvesting one areas while planting the next, the net contributions to the atmosphere over long time periods are nil. There are some problems with it, but I think there is progress being made.

I suspect you have talked to Bob Williams and his biomass gas turbines. These are all prospects for electricity from biomass.

Senator WIRTH. Thank you very much. Is there anything you would like to add for the purpose of the record?

Dr. MARLAND. I think in a rambling sort of way I have gotten through what I have here.

Senator WIRTH. It is very, very interesting, and we thank you very much for coming and joining us and trying to illustrate to people what the carbon dioxide issue is in as many pieces of it as possible.

Dr. MARLAND. Thank you for staying, sir. I am coming to your house for dinner now. My plane left 14 minutes ago. [Laughter.]

Senator WIRTH. Terrific. That is fine. I look forward to that. Thanks ever so much.

[Whereupon, at 6:15 p.m. the hearing was adjourned.]

APPENDIX

RESPONSES TO ADDITIONAL QUESTIONS

Department of Energy
Washington, DC 20585

September 7, 1989

The Honorable J. Bennett Johnston, Chairman
Committee on Energy and Natural
  Resources
United States Senate
Washington, D.C. 20510

Dear Mr. Chairman:

On July 26, 1989, Secretary James D. Watkins gave testimony before your committee on the formulation of a National Energy Strategy and related policies which affect global climate change.

Following that hearing, you submitted written questions, including questions on behalf of Senators Timothy E. Wirth, Don Nickles, and James A. McClure. Enclosed are the answers to those questions, which also have been sent to Senators Wirth, Nickles, and McClure.

If you have any questions, please have your staff call Michael Gilmore on 586-4277. He will be happy to assist.

Sincerely,

Robert G. Rabben
Assistant General Counsel
  for Legislation

Enclosures

POST-HEARING QUESTIONS AND ANSWERS

FROM THE

JULY 26, 1989, HEARING

BEFORE THE

COMMITTEE ON ENERGY AND NATURAL RESOURCES

UNITED STATES SENATE

WITNESS: ADMIRAL JAMES D. WATKINS

SECRETARY OF ENERGY

QUESTIONS FROM SENATOR JOHNSTON

Question 1: The Committee has requested views and estimates from DOE on the Wirth bill, S. 324, in January of this year. Will you provide the Committee with an indication as to when the Department might be able to provide these comments?

Answer: The Department recently provided extensive comments on the bill to OMB, which in turn, is circulating them to other agencies for their review. We will be happy to provide our final comments to you once the interagency review process has been completed.

QUESTIONS FROM SENATOR JOHNSTON

Question 2: Funding was provided to DOE in the FY 89 appropriation for the National Academy of Sciences to conduct a pivotal study on alternative energy R&D strategies toward stabilizing global greenhouse gases. What is the status of that study?

Answer: The National Academy of Sciences (NAS) project on alternative energy R&D has begun and the NAS has held the initial meeting of its special committee which will be responsible for conducting the study. It is expected that the study will be completed in early summer of 1990.

QUESTIONS FROM SENATOR JOHNSTON

Question 3(a): Mr. Secretary, you have made hopeful and general statements on the greenhouse problem. In your confirmation hearings, and in other recent speeches, you have acknowledged the need to act and take certain immediate steps.

1. Can you tell us what those steps are?

Answer: I believe the following actions and principles should guide our near-term response to global climate change policy:

a) We should take aggressive action on issues where scientific consensus exists.

b) Where scientific consensus does not exist, we should assess the state-of-the-science to identify appropriate areas for further inquiry.

c) Where scientific uncertainty exists, we nevertheless should move forward with measures that would reduce emissions of greenhouse gases and that also make sense for other policy reasons. Today, these measures include: (1) increased energy efficiency and renewable energy, (2) reduction and phaseout of the

Answer 3(a)
Continued

chlorofluorocarbons controlled under the Montreal Protocol, and (3) working with developing countries to reduce net deforestation and, in time, to cause net reforestation.

d) We should consider the economic consequences of measures proposed to respond to the potential global climate change threat.

e) Analysis of response measures should be well grounded on scientific and technical information.

f) We must determine how to evaluate and share technological and policy response measures with countries. We must work with these developing countries to achieve needed environmental objectives in a manner that does not compromise legitimate economic objectives.

QUESTIONS FROM SENATOR JOHNSTON

Question 3(b):	What immediate policy steps is the Department willing to take on a parallel course with continued research on global warming?
Answer:	At the President's request, DOE is developing a National Energy Strategy (NES). The issues associated with global climate change will be carefully considered in the process of developing an appropriate strategy. The NES will identify particular measures DOE should undertake, directly or in conjunction with other Federal Departments and Agencies, to implement energy policies that also respond to climate change concerns.

QUESTIONS FROM SENATOR JOHNSTON

Question 3(c): **Does the President believe we should support policies to reduce CO2 emissions?**

Answer: President Bush has articulated a clear greenhouse policy strategy in several international meetings, most recently in the Group of Seven Economic Summit in Paris. In the summit communique, President Bush was joined by the leaders of the other major industrialized countries in calling for the development of a framework convention to address climate change. Such a convention should assist in coordinating the development of an improved scientific understanding of climate change and establish procedures to facilitate the formation of an international consensus. President Bush believes that an international agreement is critical to any actions on climate change. In the meantime, as I have indicated above, there are actions which are worth taking on

Answer 3(c) continued:

grounds other than climate change, but which also contribute to reducing greenhouse gas emissions. I believe these principles are in line with the greenhouse strategy President Bush has articulated.

QUESTIONS FROM SENATOR JOHNSTON

Question 4: Since 1978, there has been a statute on the books requiring DOE to submit a national energy plan every two years. The Reagan Administration made an attempt to comply with this law by submitting a report last year which used outdated numbers and established energy targets which were on par with what EIA predicted were going to happen anyway. How is the Bush plan going to differ from the Reagan Administration's efforts and what assurances do we have that these goals will be met?

Answer: At the White House on July 26, the President announced the development of a National Energy Strategy (NES). The strategy will be built around the fundamental premise that our energy requirements must be reconciled with our desire for a safe and healthy environment. The development of a National Energy Strategy will be a key energy initiative of the Bush Administration. A series of fact-finding public hearings, which began on August 1 in Washington, D.C., marked the beginning of the development process. Future hearings will solicit testimony on specific topics. In addition, the Department is developing a National Energy Modeling System that will substantially improve both our analytical and our forecasting capability.

The Bush Administration Energy Strategy will differ from the policy plans submitted by previous Administrations by providing a framework for reconciling policy,-program, and budget decisions.

Answer 4 continued: An interagency review and clearance process, under the aegis of the Economic Policy Council, has been established for the purpose of assuring that National Energy Strategy goals will be met.

Because this policy, program, and budget integration goal is new, and is a significant departure from past Departmental plans, it will take time. Accordingly, the Department has requested an extension from the requirement that a plan be delivered to Congress in 1989. A first draft of the NES will be transmitted to Congress by April 1, 1990.

QUESTIONS FROM SENATOR JOHNSTON

Question 5: Does utility regulation discourage conservation? What is the Department's role in promoting conservation through the utilities? What specific measures do you feel will be needed to make conservation more palatable to the utilities?

Answer: Regulation itself does not discourage conservation, but some regulatory decisions may have that effect. Regulation is usually crafted to achieve several competing objectives. Compromises and balances are an important part of the process. If regulators set prices too low, customers will lack sufficient economic incentives to conserve. If prices are set too high, the conservation gains are outweighed by slower economic growth.

Although conservation has traditionally been the domain of customers, some utilities are beginning to view conservation as a resource of equal value to new capacity, and some public utility commissions are looking at ways to treat conservation on an equal footing with generation. Some important utility conservation programs have been undertaken by DOE's Power Marketing Administrations, others by electric power producers such as Duke Power of North Carolina.

Answer 5 continued: The most direct role that DOE can play in promoting conservation is through policies and technology development that support it. There are substantial opportunities for improved efficiencies in the conversion of fuels to electricity. Some of these offer the added benefit of reduced emissions and lower electricity prices.

The Department of Energy encourages regulatory innovations that cause utilities to share in the costs of poor efficiencies and allows them to share in the benefits of high efficiencies. The Department will examine, in the development of the National Energy Strategy, the role that competition and other regulatory reforms can play in providing utilities with incentives to use energy more efficiently.

QUESTIONS FROM SENATOR JOHNSTON

Question 6: You propose a series of hearings around the country to receive testimony on a national energy policy. What will be the Department's procedure for disseminating information to the public in each of the regions prior to the hearings?

Answer: The goal of the first series of hearings is less to disseminate information to the public than to solicit information from the public on what the priorities of DOE should be in developing a NES. Our procedure for disseminating information to the public prior to each of the hearings is to make announcements to the press and to publish a Federal Register notice.

Public hearings planned for November and December will provide further opportunities for DOE to share with the public the extensive information that is being collected in conjunction with NES development. In the Spring, the Department intends to release its first draft of the NES, and to seek public comments on this document over a period of six months. The NES will then be finalized and submitted to the President in December 1990.

QUESTIONS FROM SENATOR JOHNSTON

Question 7: **Mr. Marland states in his written testimony that France has reduced their CO2 emissions by 30 percent since 1979. Do you believe this is a direct result of their nuclear power program and could the United States achieve the same type of reductions through a stepped up nuclear program.**

Answer: The nuclear program in France is almost certainly a major factor in the reduction in CO2 emissions that France has experienced over the last ten years. The nuclear energy share of French total electricity production rose from about 30% in 1980 to approximately 70% by 1989. Energy efficiency gains and other fuel switching have also contributed to reduced French CO2 emissions.

If it were deemed necessary for the U.S. to achieve the level of CO2 emissions-reduction experienced by France over the last decade, a variety of options would have to be considered in addition to expanded substitution of nuclear for fossil fuel electricity generation. Those additional options include increased energy efficiency in both supply and end-use, expanded use of renewables, and

Answer 7 continued:

substitution of natural gas for high carbon content fuels. The existing U.S. energy resource base, range of technological options, and system size and complexity are radically different than those of France, and a program for the efficient attainment of any CO2 emissions reductions would necessarily be different than in the case of France.

QUESTIONS FROM SENATOR JOHNSTON

Question 8:	Would the large-scale introduction of compressed natural gas vehicles for bus mass transit, U.S. Postal Service, U.P.S., telephone repair, van, and other fleet use have a material effect on reducing greenhouse gases and other air quality problems?
Answer:	In general, the use of natural gas results in approximately 25 percent less combustion-generated carbon dioxide (CO_2) than does gasoline. This benefit may be partially offset by increases in emissions of methane -- a greenhouse gas -- during combustion and refueling. With regard to other air quality problems, well-designed natural gas vehicles will likely have lower emissions of reactive hydrocarbons, which will help reduce ozone levels.

How significant the contribution of compressed natural gas (CNG) vehicles can be depends on (1) the relative emission levels of the conventional vehicles they replace and (2) the total number of CNG vehicles introduced into the fleet. As the exhaust and refueling emissions of conventional vehicles are reduced, alternative fuel vehicles will provide a modest, but still important, per-vehicle benefit.

However, the overall benefit of conversion of "fleet" vehicles in the U.S. is limited by the small

Answer 8 continued: fraction of vehicles that are actually in centrally-garaged urban fleets. These fleets are the most likely targets for initial CNG introduction, and comprise about 5% of the vehicles in urban areas.

While we have not done a detailed analysis of this issue we can make an estimate of the potential impact. If the per-vehicle emissions improvement is on the order of 50%, it would take a 5 to 10 year program of substitution of CNG vehicles into centrally-garaged fleets to produce a 1% to 2% reduction in motor vehicle emissions of ozone-producing reactive hydrocarbons.

QUESTIONS FROM SENATOR WIRTH

Question 1: In the development of the National Energy Strategy, Mr. Secretary, what priority would you attach to environmental matters in general and specifically to reducing carbon dioxide emissions?

Answer: Environmental matters are central to the development of the National Energy Strategy. Environmental protection, important in its own right, is also important to economic efficiency, because energy policies and technologies that inadequately protect the environment are not sustainable in the long run.

With respect to greenhouse gas emission reduction policies, I have indicated in past public statements that we should move aggressively to mitigate emissions where current knowledge and cost-effectiveness support action. Where scientific uncertainty exists, we nevertheless should move forward with measures that make sense for other policy reasons. Today, these measures include: (1) increased energy efficiency and renewable energy, (2) reduction and phase-out of the chlorofluorocarbons controlled under the

Answer 1
continued:

Montreal Protocol, and (3) working with developing countries to reduce net deforestation and, in time, to cause net reforestation.

QUESTIONS FROM SENATOR WIRTH

Question 2:	More specifically, I would like to know whether the Department of Energy believes that CO_2 emissions should be reduced? Do you have a "CO_2 policy"? Has the President asked you to develop recommendations for reducing emissions of greenhouse gases?
Answer:	The Department recognizes the seriousness of the concerns over the possibility of significant global warming due to the increase of greenhouse gases in the atmosphere. Until the scientific uncertainties which underlie this concern are resolved, the Department believes that it would be prudent to minimize the emission of CO_2 as well as the other greenhouse gases wherever possible. President Bush has joined the leaders of the other major industrialized nations in saying: "We strongly advocate common efforts to limit emissions of carbon dioxide and other greenhouse gases, which threaten to induce climate change, endangering the environment and ultimately the economy." The Department's CO_2 policy is to identify those actions to reduce greenhouse gas emissions which are justified within the context of a National Energy Strategy.

Answer 2 continued:

The President has not specifically requested the Department to develop recommendations to reduce emissions of greenhouse gases. However, the Department has been evaluating a complete range of possible actions. This evaluation, which will be available this fall, will include consideration of both economic and the environmental consequences of such actions. The Department's specific recommendations will appear as part of the National Energy Strategy.

QUESTIONS FROM SENATOR WIRTH

Question 3: For the past several years, "least-cost" planning has been the clarion call of environmentalists and promoters of energy-efficiency. As with much of the utility regulatory process, it is a difficult planning mechanism to understand. In March, a representative of the Bonneville Power Administration presented the committee with one of the most cogent analyses of least-cost planning. She said, "Our first step is to put all power resources, and that includes nuclear, coal, hydro, cogeneration, as well as conservation on comparable footing in terms of the amount that is available at a certain price, taking into account such things as lead time, environmental impacts and other features."

She went on to say that "the second step is to figure out how much power you need. The third step is to figure out which mix of resources most cost-effectively meets these future needs."

Mr. Secretary, does that sound like a reasonable process to you?

Answer: Yes. The process described is a reasonable one that requires considerable analysis of available resources, costs and benefits. DOE is working with utilities, regulators, state and local governments, trade associations, consultants, the energy industry, national laboratories and other researchers to provide a national perspective to support least-cost utility planning (LCUP). Our objective is to broaden and accelerate its implementation through mechanisms that: (1) assure consideration of demand-side measures on an equal footing with supply options; and (2) ensure the supply of efficient, reliable, and low-cost energy services. Present and long-term evaluation priorities include: (1) assessing the regulatory alternatives that reward utilities for implementing successful least-cost plans; (2) expanding training, networking and other technical-support activities that share information among

Answer 3
continued:

researchers and utility planning personnel; (3) encouraging and documenting successful institutional arrangements for least-cost planning processes and programs; (4) developing and disseminating information on the technical performance and costs of demand-side management technologies and programs; (5) providing the technical basis for incorporating environmental and other social factors into LCUP; and (6) stimulating the creation of a variety of technical information and data services that can work cooperatively as a national referral network on LCUP.

QUESTIONS FROM SENATOR WIRTH

Question 4: The omnibus global warming bill I have introduced includes a provision that would require DOE to submit a national least cost energy plan? I urge you to consider this framework as you proceed with the national energy strategy. And for 5 months we have been waiting for comments on this bill from the Department, when can we expect a response?

Answer: The Department recently provided extensive comments on the bill to OMB, which in turn, is circulating them to other agencies for their review. We will be happy to provide our final comments to you once the interagency review process has been completed.

QUESTIONS FROM SENATOR WIRTH

Question 5: I do not quite understand why there are no studies requested on the availability of fossil and nuclear energy resources? Shouldn't we compare all potential resources on the table and determine which are the cheapest and cleanest and then go about acquiring them? Finally, do you anticipate undertaking an effort to determine the "external" cost of a particular energy resources? In other words, will the National Energy Strategy attempt to quantify the societal costs -- including health care costs, the costs of resource destruction, etc. -- of using one form of energy versus another?

Answer: The Department has many studies on the availability of fossil and nuclear energy resources, and would be pleased to provide particular information on these resources. In order to develop the National Energy Strategy we are preparing new profiles of energy by fuel and by end-use sector. We are also developing total fuel cycle costs so that our assessment of the costs of energy alternatives considers the costs of waste treatment and disposal, as well as extraction and generation costs. Our objective is to provide the Nation with a balanced mix of energy resources that will meet future energy requirements in the most economical and environmentally beneficial way.

QUESTIONS FROM SENATOR WIRTH

Question 6: I understand that a number of studies will be undertaken to determine the availability of various resources. I am interested in knowing whether there will be equity in funding the studies on demand-side (conservation) resources? Also, will these studies be converted into permanent data-bases that can be updated regularly.

Answer: For the National Energy Strategy, studies will be conducted on energy supplies and demand; on energy consumption in each end-use sector of the economy; and on all fuels and technologies. The Secretary has said that he views conservation/demand-side planning as a source of energy no different than fossil or renewable fuels. The potential of all these sources must be assessed.

Energy demand data developed by the Department for the National Energy Strategy will become a permanent and important part of the Department's data-base and modeling system. This information will be updated on a regular basis.

QUESTION FROM SENATOR NICKLES

Question 1: Does the Department, as part of its National Energy Strategy, intend to review the comparative benefits of all the alternative motor fuels, including additives such as MTBE and ETBE?

Answer: The National Energy Strategy will attempt to reflect the potential contribution of all alternative motor fuels, from compressed natural gas to hydrogen. A more detailed examination of their comparative benefits will be undertaken as part of the work of the Interagency Commission on Alternative Motor Fuels, established by the Alternative Motor Fuels Act of 1988; the Commission recently met for the first time, under the leadership of Deputy Secretary Henson Moore.

These reviews will focus primarily on the use of such fuels as substitutes for gasoline, rather than as extenders or additives. The success of additives such as MTBE and ETBE will be determined chiefly by the marketplace, although EPA is charged with regulating the content of gasoline blends and the Treasury Department is considering the appropriate tax treatment of ETBE.

QUESTIONS FROM SENATOR McCLURE

Question 1:	What is missing is a national energy awareness of the seriousness of the United States' dependence on oil imports. How do you propose to increase the awareness of American consumers in this regard?
Answer:	It will take concerted efforts by national, state and local leaders to increase public awareness of the risks posed by increasing oil imports. Through the public hearing process currently underway to help develop a National Energy Strategy, we hope to educate the public about the consequences of oil import dependence, and about the costs and effects of the policies we choose.
	In the National Energy Strategy, DOE will examine the policy options available to the nation if present oil import trends are to be modified, and will make recommendations for corrective action. Public review and comment on these recommendations will provide another opportunity to educate the public and decision makers.

QUESTIONS FROM SENATOR McCLURE

Question 2(a): This hearing is on the national energy strategy in the context of concern for global warming. The hearing could just as well be on the national strategy for achieving greater energy independence consistent with national as well as international environmental concerns.

In your judgment, Mr. Secretary, can we formulate a national energy policy without concern for its impact on global warming or clean air?

Answer: In my judgment we cannot formulate a national energy strategy without concern for its potential impact on climate change or on clean air. An assessment of global climate change issues is part of the design of the National Energy Strategy (NES) process now under way. That effort is guided by six principles:

1. Take aggressive action on those issues on which scientific consensus exists.

2. Assess the state of the science on issues where consensus does not exist, and identify areas for further inquiry.

3. Where scientific uncertainty exists, move forward with those measures that make sense on other grounds, e.g., efficiency and reducing CFCs.

Question 2(a) continued:

4. Consider the costs and benefits of any measures suggested.

5. Link responses to scientific and technical information.

6. Determine how to evaluate and share technological responses with developing countries.

QUESTIONS FROM SENATOR McCLURE

Question 2(b): Conversely, can we formulate national environmental policies without concern for their impacts on our national energy strategy?

Answer: With respect to clean air, it is important to point out that there is considerable overlap between measures to improve air quality and measure to improve energy production and consumption. Thus measures undertaken for one purpose may serve other purposes as well.

I believe that energy and environmental policies are inextricably linked and that one cannot formulate one without assessing the impact it will have on the other. The President's proposed Clean Air Act amendments thus attempt to balance the impact of environmental action on the energy sector. It will be our duty to craft energy policy similarly with sensitivity to the environmental consequences.

QUESTIONS FROM SENATOR McCLURE

Question 3(a): As you know, Mr. Secretary, the Clean Air Act amendments proposed by the Administration will have very profound impacts on our nation's energy future.

What do you see as the energy policy implications of the Administration's Clean Air proposal?

Answer: The Administration's Clean Air proposal puts national energy policy on a new track forcing an explicit recognition that the use of energy resources involves not only the costs of extraction, processing, transportation, and consumption, but also environmental and health costs.

We are in the process of fully assessing the implications of the President's Clean Air Act proposals for energy policy, and we intend to discuss this issue in the forthcoming National Energy Strategy. What I can say at this time is that the Administration proposal helps to balance our tandem national goals of continued economic growth and improved quality of life. The proposed amendments would allow industrial and utility managers flexibility to provide energy services in the most efficient and environmentally responsible manner. Cleaner fuels, better technologies, and improved end-use

Answer 3(a) continued: efficiency will all continue to be encouraged under the Administration's proposal.

QUESTIONS FROM SENATOR MCCLURE

Question 3(b): As you know, Mr. Secretary, the Clean Air Act amendments proposed by the Administration will have profound impacts on our Nation's energy future.

Were any assumptions made regarding possible fuel switching to gas, nuclear or other energy forms?

Answer: The basic scenarios used in the analyses were developed by the EPA. While EPA's scenarios suggest that adoption of the President's proposed legislation would increase gas usage, the models are not sufficient to provide full details on fuel switching.

QUESTIONS FROM SENATOR McCLURE

Question 3(c):	What specific considerations were given by the Administration to the impact of the Administration's proposal upon the continued use of coal?
Answer:	The Administration's principal consideration was to place all types of coals on as level a playing field as possible.

- Specifically, the amendments were written to allow freedom of choice and cost minimizing market-based solutions to the control requirements specified. Freedom of choice allows a utility to select from the menu of control options that are available, e.g., scrubbers, coal switching, clean coal technologies. The marketable permits proposal will allow sources to minimize their control costs by optimizing the reductions they will be required to achieve.

- States are given the authority to limit or prohibit coal switching if so desired to minimize impacts on their economy.

- Incentives are afforded for the use of clean coal technologies which will improve the competitiveness of coal at new and existing facilities.

QUESTIONS FROM SENATOR MCCLURE

Question 3(d): **Has the Department done its own assessment of the energy policy implications of the proposal? When do you expect to have that analysis completed?**

Answer: Many of the specifics of the Administration's proposal were undergoing change during July. We are presently conducting an extensive analysis of the bill. This should be completed later this fall.

QUESTIONS FROM SENATOR MCCLURE

Question 4 (a): For more years than I care to remember, many of us in the Congress have labored to remove artificial constraints on domestic energy markets. Only a few hours ago, some of us participated in a signing ceremony at the White House where the President signed legislation to remove Federal price controls on natural gas, which have existed since 1954. During the last Congress, we repealed the Fuel Use Act which established coal as the fuel of choice for electric power generation.

a. Do you agree with my assessment that the Administration's proposal for the control of acid rain effectively designates natural gas and nuclear as the fuels of choice for electricity generation? As I understand the proposal, the controls on nitrogen oxides only apply to oil and coal facilities.

Answer: The Administration's acid rain proposal does not dictate that natural gas and nuclear will be the fuels of choice for electricity generation. Rather, it has set an environmental goal and provided utilities with the flexibility to determine the most economical methods of compliance.

Coal remains our nation's most abundant fuel resource, and will continue to remain an essential part of our energy mix. The President's continued commitment to coal is evidenced by the full funding of the

Clean Coal Technology Demonstration Program and the incentives provided in the acid rain proposal for the deployment of these innovative technologies. You are correct that the control of oxides of nitrogen only apply to coal and oil facilities.

QUESTIONS FROM SENATOR MCCLURE

Question 5(a) There is a very complex trading system and other limitations on compliance in the Administration's Clean Air proposal.

a. In your judgment, what do you anticipate will be the effect of the proposal on the pattern and mix of fuel use in the United States?

Answer: Analysis is currently underway to determine the effect of the President's proposal on the pattern and mix of fuel use in the United States.

Past analysis of acid rain proposals conducted by the Deparment, not identical to the current proposal, indicate significant cost savings for inter-state trading (when compared to intra-state trading) where no constraints are placed on utility choice of coal or on the compliance method chosen.

QUESTIONS FROM SENATOR MCCLURE

Question 5(b) To what extent, if at all, were these concerns considered as the Clean Air Proposal was being formulated?

Answer: A number of analyses previously done by DOE and by EPA were available and were considered by the interagency group that formulated the Clean Air proposal.

QUESTIONS FROM SENATOR McCLURE

Question 6(a): I am concerned that the proposed amendments do not provide any commensurate role for the Department of Energy.

What do you perceive to be the role of the Department under the amendments? In your judgment is that role what it should be?

Answer: One would not expect a Department of Energy role commensurate with that of the Environmental Protection Agency (EPA) in a legislative proposal to amend the Clean Air Act (CAA). It is the EPA that has the statutory responsibility to administer and implement the Clean Air Act.

The clean coal technology (CCT) provisions of the CAA amendments are designed to allow DOE's CCT program to be successful. They provide DOE an opportunity to contribute to environmental policy by developing innovative technology.

Similarly, DOE has an appropriate role in the Clean Fuels Program proposed by the President. The EPA Administrator would be required to consult with DOE in the promulgation of regulations by which the program will be implemented.

Answer 6(a) continued:

Additionally, the Administrator would consult with DOE in reaching a determination as to what technologies constitute a "repowering" that would entitle the owner or operator of an existing pulverized coal boiler to the grant of a compliance date extension under Section 508.

QUESTIONS FROM SENATOR McCLURE

Question 6(b): Frankly, I am disturbed by the report in Tuesday's Energy Daily that, according to administration sources, the President's proposal was written almost entirely by OMB and EPA and that repeated attempts by DOE to intervene, particularly on the acid rain issue, failed. I also am disturbed by the minimum, if any, role for the Department of Energy in the Administration's proposal?

Answer: The Department of Energy was represented on all interagency working groups established by the Administration to develop the Clean Air Act amendments. It is true that the EPA had the principal responsibility for writing the legislation. The DOE, however, participated actively in the drafting process.

EPA is responsible for administering and implementing the Clean Air Act. The role of the Department of Energy in the Clean Air Act amendments is appropriate given EPA's primary role with respect to environmental law. It should be noted that both the clean coal technology and the clean fuels provisions of the President's proposal call for substantive DOE participation.

QUESTIONS FROM SENATOR McCLURE

Question 7: Would you comment Mr. Secretary on the report in Tuesday's Energy Daily that, according to Administration sources, EPA and OMB decided to take an especially tough line on acid rain because they believe it had no political negatives, and could win the administration support. One source is quoted as saying that "No matter what we would do the utilities would scream bloody murder. So we decided to really get tough with them." Do you agree with this assessment of the situation?

Answer: I will not speculate on the various press reports of the deliberations that took place within the Administration in the drafting of the President's Clean Air Act amendments.

What can be said is that all aspects of the Clean Air Act proposals were intensively debated with a view to minimizing negative economic impacts, maximizing flexibility with respect to compliance, and obtaining significant and measurable environmental benefits.

QUESTIONS FROM SENATOR McCLURE

Question 8(a): Looking specifically at the Acid Rain title of the Administration's clean air proposal, there are rigid emission caps and there is a requirement that new sources purchase offsets. After the year 2000, all grass root energy facilities must secure sufficient offsets to achieve zero emissions on a net basis.

What is your assessment of the effect of these requirements on the growth of electricity supplies regionally and nationally?

Answer: It must be recognized first that the cap in HR 3030 applies only to sulfur dioxide emissions. Only coal and residual oil have substantial amounts of sulfur dioxide emissions, and very low sulfur residual oil (e.g., 0.3%) is readily available. Hence, if there is an effect, it will relate to future coal-fired generation. Also, note that under HR 3030, emissions from all generation which begin operations after the date of enactment must be offset, not just capacity brought on line after 2000. With these points in mind, DOE performed a brief analysis of how the cap might influence the cost of coal-fired power through the year 2030.

Since the cap is permanent, analysis of these issues requires making assumptions about the distant future, i.e., through the year 2030. The most critical assumptions are the life expectancy of existing coal plants, the future level of coal use, and the emission control to be applied to new units. For this analysis, it was assumed that coal

Answer 8(a) continued:

uses doubles current levels in 2015 and triples current levels in 2030. Powerplants were assumed to retire after 65 years of operation. The table below shows that for different performance levels of the additional capacity there may or may not be a problem.

Cost of offsetting new units ($miln/yr)
for emissions rates below (# SO_2/mmBtu)

Year	0.6	0.3	0.1
2000	1000	500	170
2010	4100	1900	200
2020	10221	1900	200
2030	20846	1900	200

For example, if new plants in the year 2030 emitted SO_2 at rates similar to today's new plants, then the cost of burning coal in new units would be prohibitive ($20 billion per year in today's dollars). If advanced technologies were used, however, then the cap would likely lead to a small additional annual cost of about $200 million per year. If future plants were a combination of existing and emerging technologies, then the cost of the cap would track in-between these two extremes and be about $2 billion per year, or roughly one-half as much as the rest of Title V's provisions after the year 2010.

Answer 8 (a) continued:

These costs have not been evaluated on a regional basis. One would reasonably expect the impact of the cap to be greater in the west than the east, because SO_2 emissions in the west are relatively small (making offsets more difficult to obtain).

The costs of the "middle" scenario in the table above would add about 2-3 dollars per megawatt-hour to the cost of power from new plants (about five percent). Hence, although the costs of the cap are large in absolute terms, they are small in relative terms, and would not have a major impact on fuel choice or conservation, so long as an active and competitive market exists in emission allowances. If such a market did not develop, then the cap would pose an obvious barrier to coal use by any utility which did not already use a significant amount of coal. Such a situation exists for many smaller utilities and for states like Texas where most existing capacity is gas fired, but most future capacity will be coal-fired.

QUESTIONS FROM SENATOR McCLURE

Question 8(b): What is your assessment of the effect of these requirements on economic growth patterns regionally and nationally?

Answer: The impact on economic growth patterns should follow directly according to one's expectations of coal technology evolution. Higher cost electricity has a dampening effect on GNP. In this case, the macro-economic impacts would be small but measurable. DRI, Inc., has performed analyses of two acid rain bills for the National Association of Manufacturers, as well as an analysis of S. 1894 for DOE/ANL. Extrapolation of those results to the less costly effect of the cap in HR 3030 suggests a slight positive effect on real GNP (in 1988 dollars) in the year 2010, which gradually becomes a somewhat larger negative effect of roughly $4 to 6 billion dollars per year from 2015 through 2030. These are coarse estimates and we have made no attempt to determine regional impacts.

QUESTIONS FROM SENATOR McCLURE

Question 8(c): To what extent, if at all, were these concerns considered as the Clean Air proposal was being formulated?

Answer: These concerns had been put on the record in discussions of earlier acid rain proposals and were considered during the formulation of HR 3030. We believe that the President's proposal represents an appropriate balance between energy and environmental concerns.

QUESTIONS FROM SENATOR McCLURE

Question 9(a): Can you elaborate on the anticipated effect of the Administration's Clean Air proposal on the Department's Clean Coal Program; specifically,

To what extent, if at all, was there an assessment of the effect of the Administration's Clean Air proposal on deployment of the specific technologies being funded by the Department under its Clean Coal Program?

Answer: There are several anticipated effects. First, it is expected that the timetable for demonstration and deployment of clean coal technologies will have to be compressed in order for these advanced options to be available in time to meet the deadlines for compliance in 1995, 2000, and 2003. Second, the uncertainty which encouraged utilities and manufacturers to defer decisions about retrofits and repowering has been reduced, and we therefore anticipate a much greater interest by both groups in supporting a clean coal demonstration program, if the program can produce tangible results in time to affect the marketplace in the 1995-1997 period.

QUESTIONS FROM SENATOR McCLURE

Question 9(b): What was the rationale for the Administration's proposal that the compliance date for clean coal technologies be limited to 3 years versus longer extensions?

Answer: The Department has assessed the effects of the Clean Air proposal on deployment of the specific technologies being funded, and which may be funded under future solicitations.

The rationale for limiting the compliance date extension beyond 2000 for only three years is that the Administration believes that is a reasonable compromise between the goal of achieving cleaner air at the earliest possible date, and the recognition that there are significant lead times associated with demonstrating and deploying new technologies.

QUESTIONS FROM SENATOR McCLURE

Question 9(c):	Why was the extension limited to so-called "repowering" technologies?
Answer:	The three year extension was limited to repowering technologies in recognition that:

- Repowering technologies take more time and money to demonstrate and deploy than retrofit technologies.

- A number of alternative retrofit demonstration projects are already proceeding under the first two rounds of the Clean Coal program and should produce operational results well in advance of the critical corporate decision dates driven by the Clean Air proposals.

QUESTIONS FROM SENATOR McCLURE

Question 10: The President's June 12th Clean Air announcement spoke of regulatory incentives. Subsequently, both the Innovative Control Technology Advisory Panel (ICTAP) and the National Coal Association recommended to you numerous regulatory incentives for assuring the commercialization of clean coal technologies. However, only two FERC-related regulatory incentives are included in the actual amendments.

Can you tell us what other regulatory incentives were specifically recommended by your Department, or otherwise considered and why they were ultimately not included in the Administration's Clean Air proposal?

Answer: All of the incentives recommended by Innovative Control Technology Advisory Panel (ICTAP) and the National Coal Council (NCC) were considered in drafting the legislation and put on the table by DOE for consideration in the President's bill. Many of the recommendations were adopted. These include the FERC regulatory incentives on accelerated amortization, and incentive rate of return; relief from the WEPCO decision; conditional preapproval of prudency (for FERC regulated projects); an extension for compliance for certain clean coal technologies; and encouragement to states to adopt a number of incentives for state regulated sources.

This list of incentives includes major ones offered by ICTAP and NCC and is consistent with their recommendations that several of their suggested incentives be adopted.

OAK RIDGE NATIONAL LABORATORY
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August 17, 1989

Leslie Black
United States Senate
Committee on Energy and Natural Resources
Driksen Office Building
Washington, DC 20510-6150

Dear Leslie:

I have a letter from Senator Johnston dated 8/3/89 with 4 follow-up questions from the July 26 hearing on carbon dioxide emissions. I enclose answers to these questions. I hope the format is appropriate.

Sincerely,

Gregg Marland
Environmental Sciences Division

GM:rmh

Enclosure

QUESTION 1:

U.S. coal contributes approximately 3 percent of total greenhouse gas emissions and has been the focus of much media attention and speculation in Congress. Is the case of coal as a contributor to warming overstated?

ANSWER:

U. S. coal contributed 7.7% of global anthropogenic emissions of carbon dioxide in 1987 (this does not include CO_2 from forest clearing). If we count all greenhouse gasses and adjust for their relative probable contributions to climate change, the current contribution of U.S. coal is on the order of 3 or 4 %. That may sound like a small number but it is one of the biggest individual contributors. Globally, 40.3% of anthropogenic CO_2 emissions are from coal burning.

QUESTION 2:

You state that domestic CO_2 emissions are rising significantly especially when compared with other developing nations such as France. What factors do you think account for this disparity?

ANSWER:

The basic data for the U.S., Canada, France, West Germany, the United Kingdom, and Japan were included with my formal remarks. I'm afraid we have not yet done sufficient analysis of the data to be able to offer substantive comments on how and why the U.S. differs from other developed nations. The obvious exception is France where it is clear that a major commitment to nuclear power has helped contribute to a lower rate of carbon dioxide emissions. I might add the observation that although per capita emissions from the U.S. are now (1987) nearly identical to what they were in 1966, total emissions from the U.S. have increased by 23%.

QUESTION 3:

Recent stories in the press have focused on the contribution of methanol to the problem of global warming. How does methanol fare in the scheme of global warming? Is there a significant difference if the methanol is derived from coal or natural gas?

ANSWER:

Mark DeLuchi and his colleagues at the University of California, Davis, have recently done extensive calculations on transportation fuels and greenhouse gasses. They have tried to account for all greenhouse gasses released, from initial resource extraction to end use, and have given comparisons with conventional gasoline powered vehicles. They convert methane and nitrous oxide to "CO_2 equivalents" on the basis of their relative probable contributions to warming. When methanol powered cars are evaluated, the answer is that it does make a very large difference where the methanol comes from. With methanol produced from natural gas, the "CO_2 equivalent emissions" are slightly less (3 %) than for conventional gasoline powered vehicles whereas for methanol produced from coal the "CO_2 equivalent emissions" are 98% more than for conventional gasoline systems. The big difference is the very large energy expenditure required to convert coal into methanol. If the primary objective were to produce a methanol fuel that could be used with minimum net emission of greenhouse gasses; it should be possible to produce methanol from biomass (wood), on a sustained yield basis, that would yield virtually no net greenhouse gas emissions.

QUESTION 4:

What is the single most important step the United States can take to reduce its output of CO_2?

ANSWER:

This question comes under the broad heading of "Really Tough Questions (RTQ)". The technical/scientific part of the answer is actually very simple - burn less fossil fuel - but then comes the "RTQ" part. My own personal view is that one important step the U.S. could take is an aggressive domestic and global leadership on population control and family planning. As population increases we can expect fuel burning to go up, forest clearing to continue, and resilience to climate and/or social change to diminish. Beyond that, I think we can all agree that significant improvements in energy-use efficiency are possible and are desirable goals for many reasons, including CO_2 emissions. One of the challenges of the greenhouse issue, however, is that there probably is no "single most important step"; that there will be a need for many contributing measures, involving many nations, impacting our lifestyles, and testing our political will. Nuclear and solar power and renewable biomass fuels can be substituted for fossil fuels to reduce CO_2 emissions.

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